

HEAT EXTREMES AND ENERGY DEMAND

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**Support provided by the CEC/PIER and CA EPA as a contribution to the
Governor's Global Warming Initiative.**

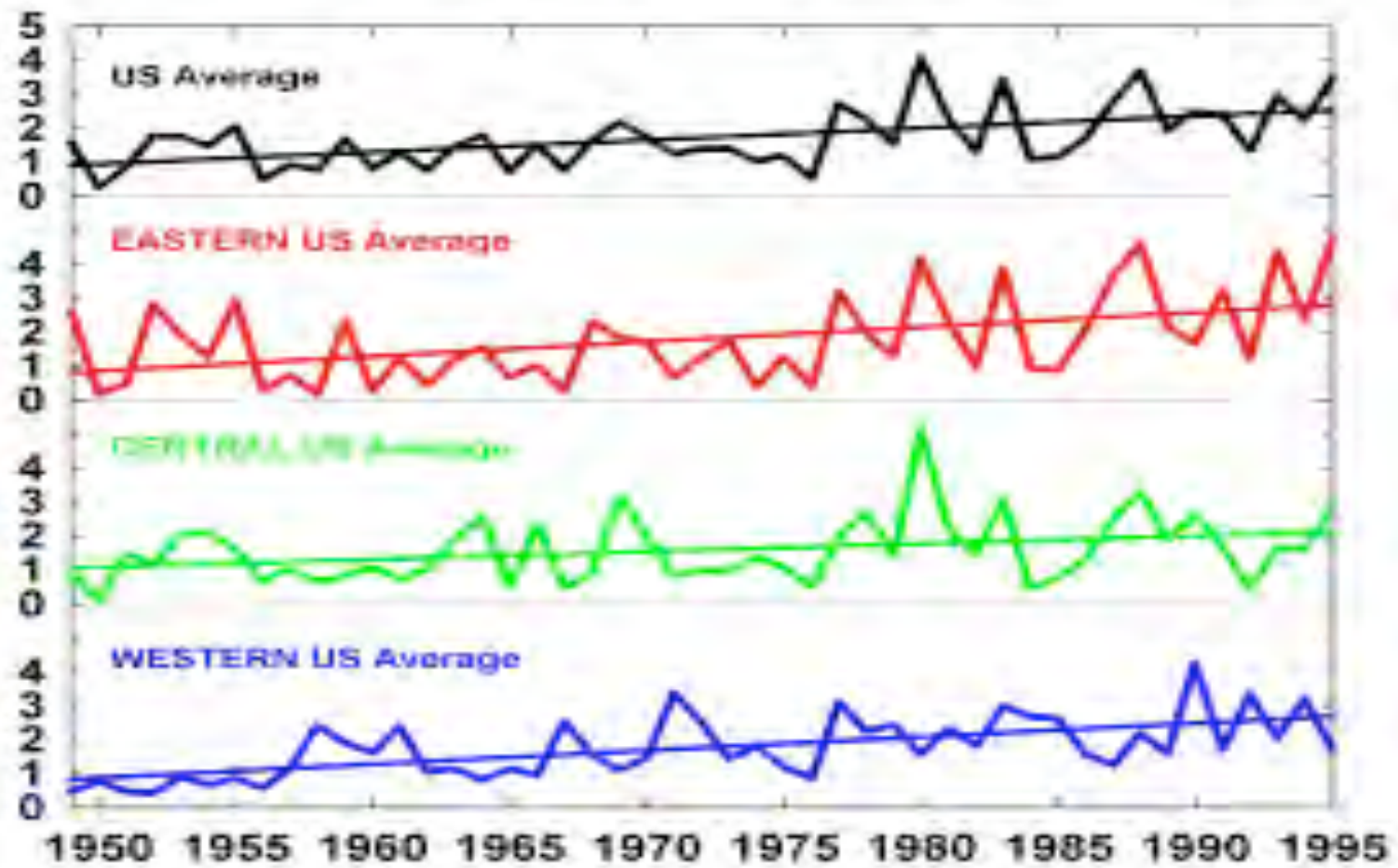
***2nd Annual Climate Change Research Conference
First Scientific Conference of the West Coast Governor's Global Warming Initiative
Sacramento, California
15 September 2005***

UC-Berkeley National

OUTLINE

- **Observed Heat Wave Trends and Records**
- **Heat Waves and Threshold Percentiles**
- **Temperature Exceedence**
- **Heat Wave Intensity and Duration**
- **Impact of Heat Extremes on Energy Demand**
- **Next Steps**

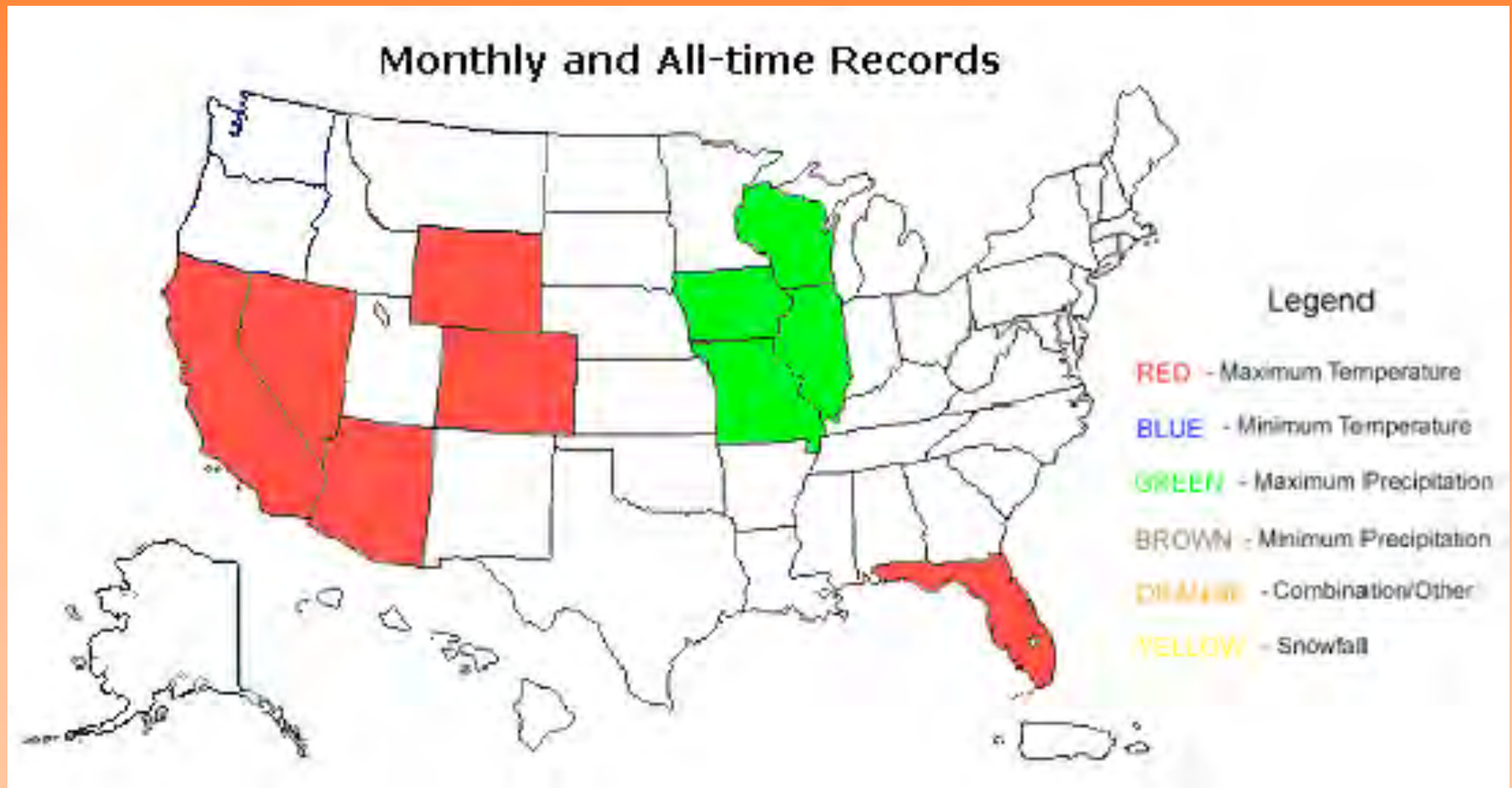
Number of 3-day Heat Waves per Year



NOAA/CDC

UC-Berkeley National

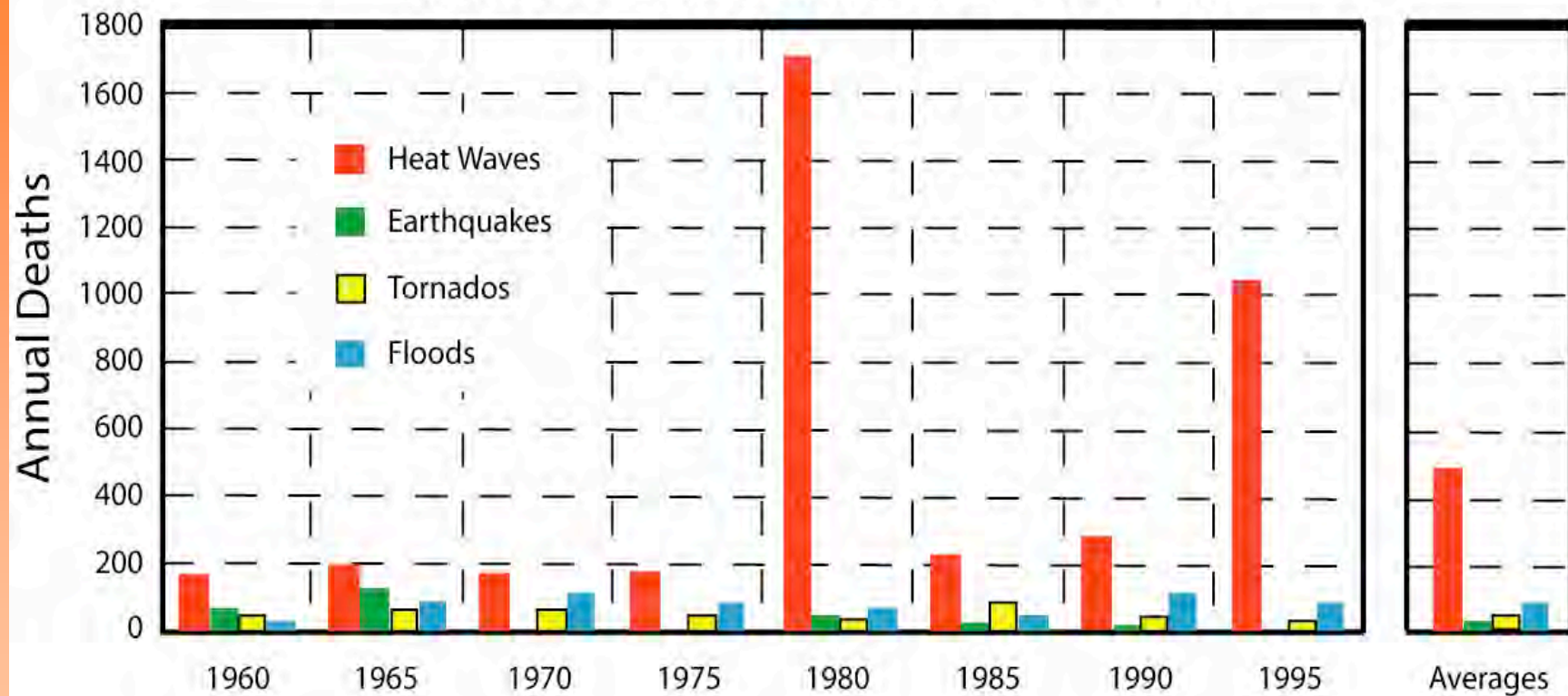
July 2005 Records



NOAA/CDC

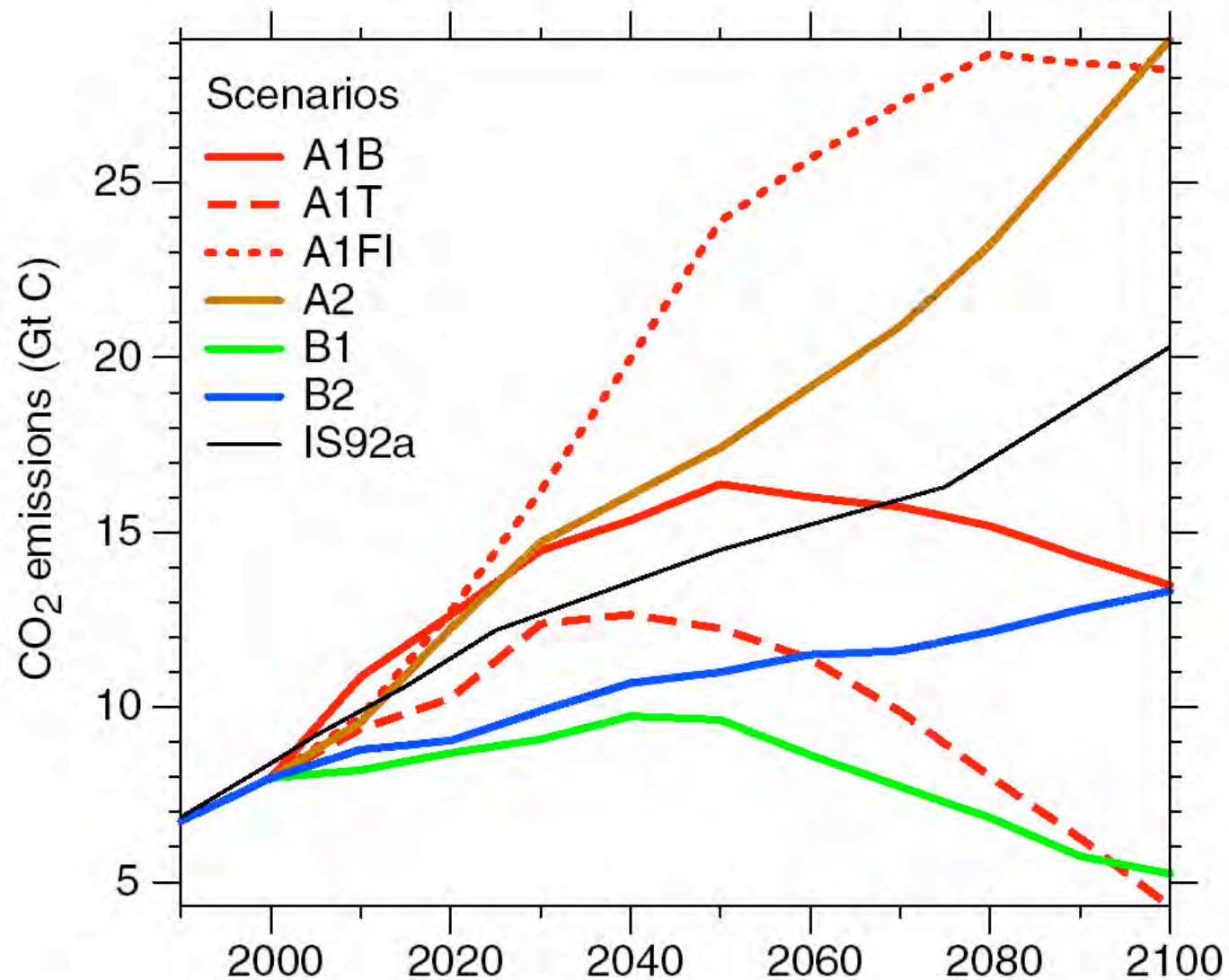
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Natural-Disaster Deaths in United States



Modified from Klinenberg, 2002, Heat Wave--Social Autopsy of Disaster in Chicago. Sources: heat waves, Vital Statistics of United States; earthquake, USGS; tornado and flood, NOAA.

IPCC Emissions Scenarios

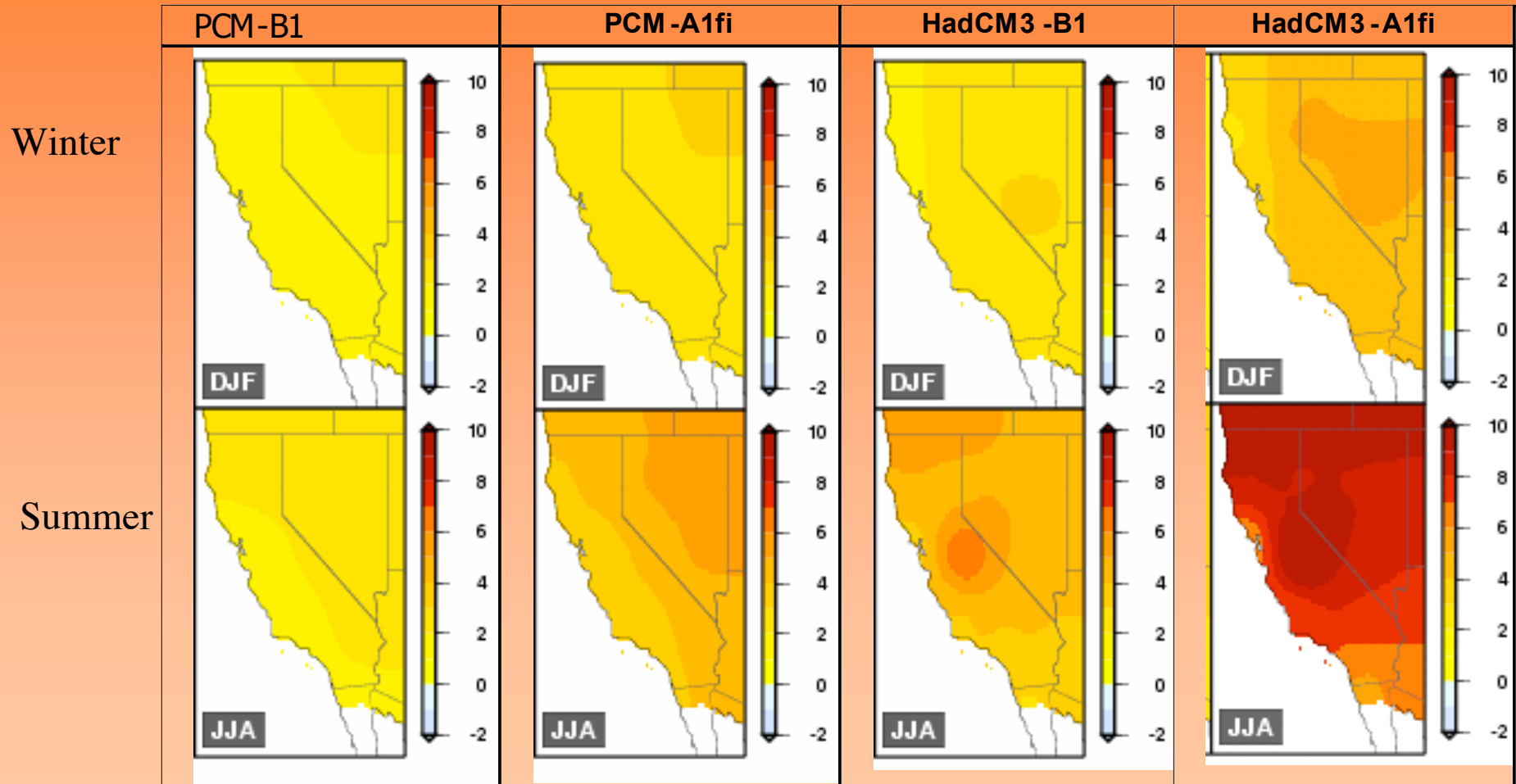


SRES

IPCC 2001

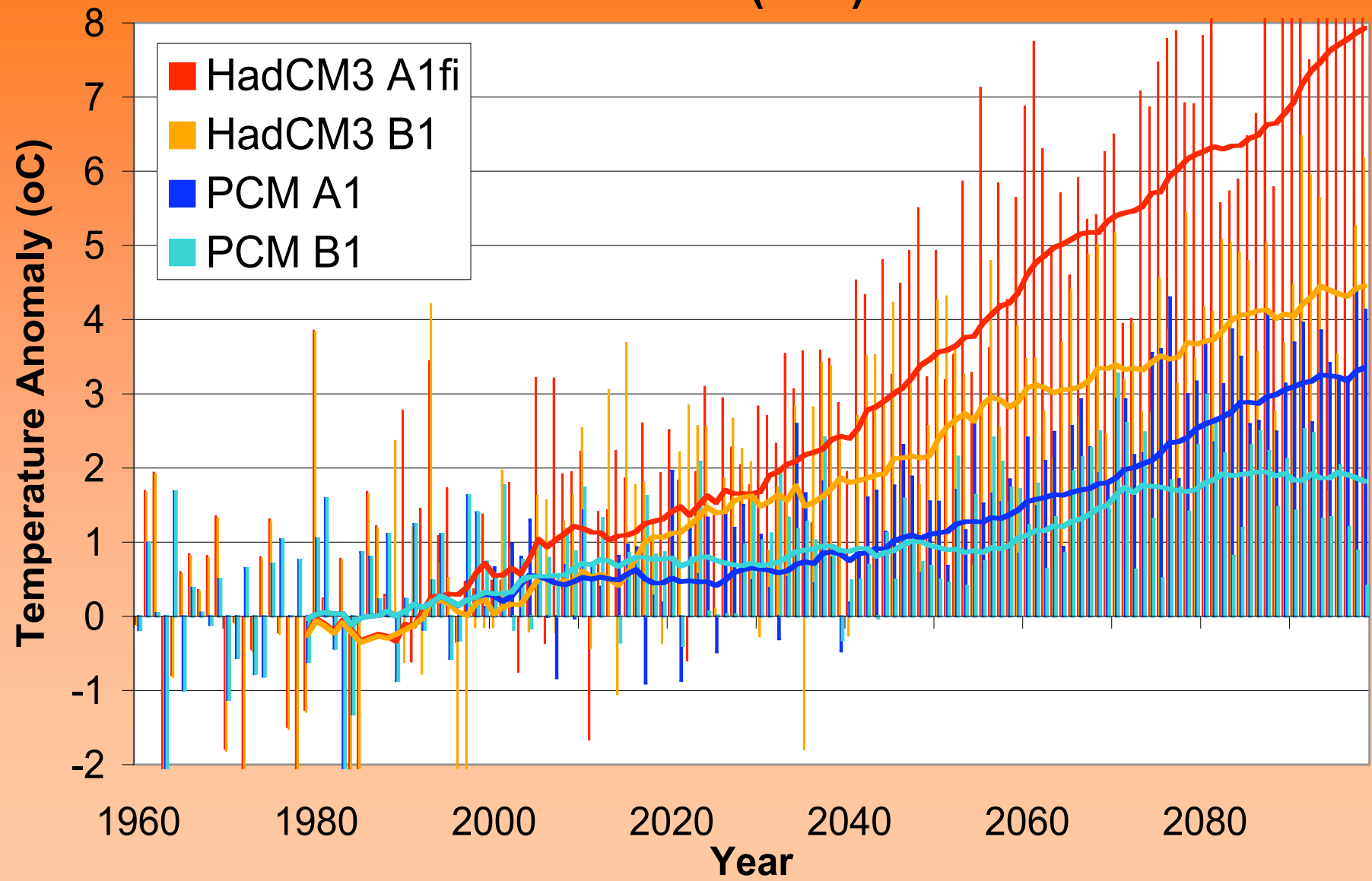
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Temperature Change (°C) Projected (2099-2070) Minus Historical (1961-1990)

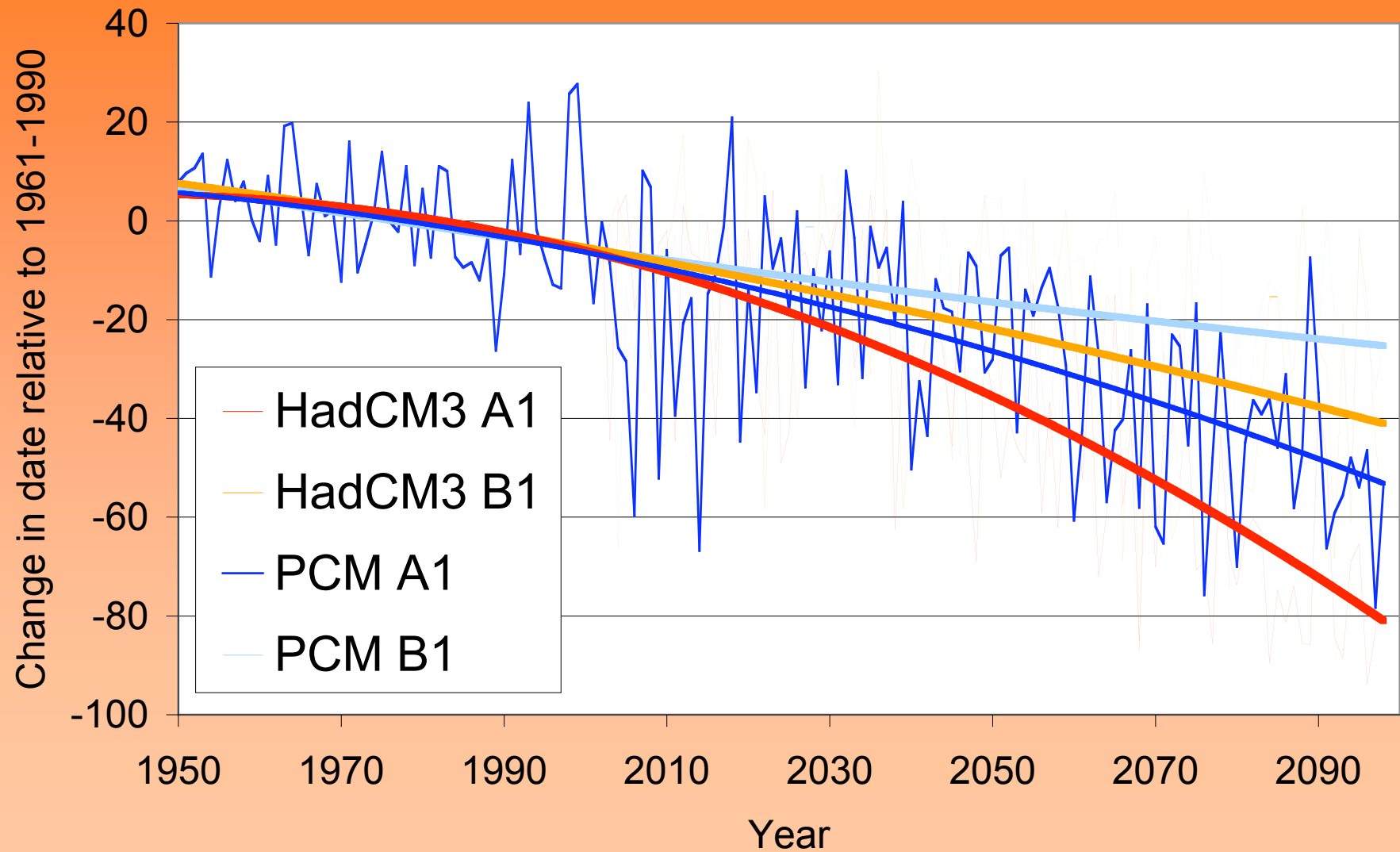


Hayhoe et al. 2004

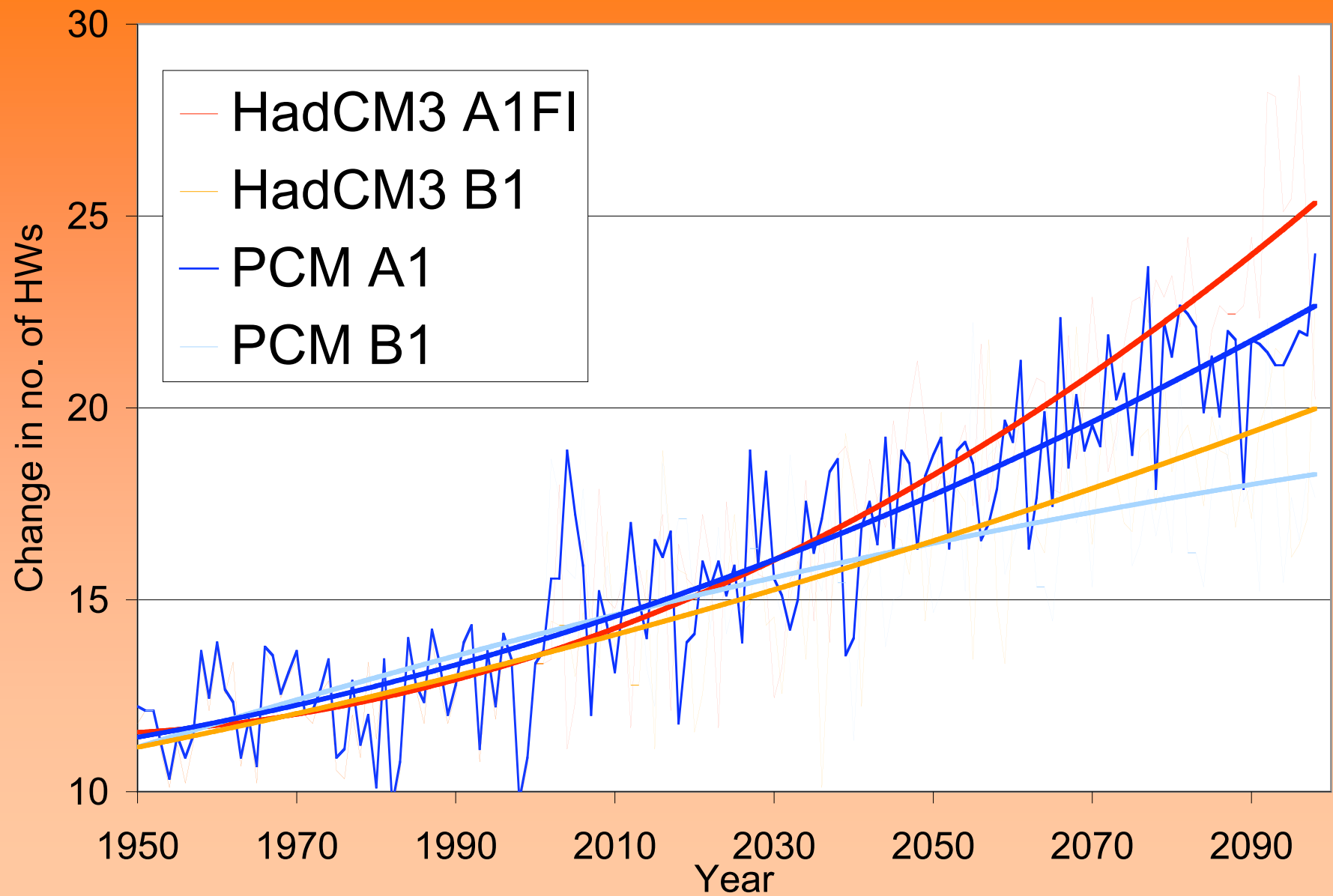
Summer (JJA)

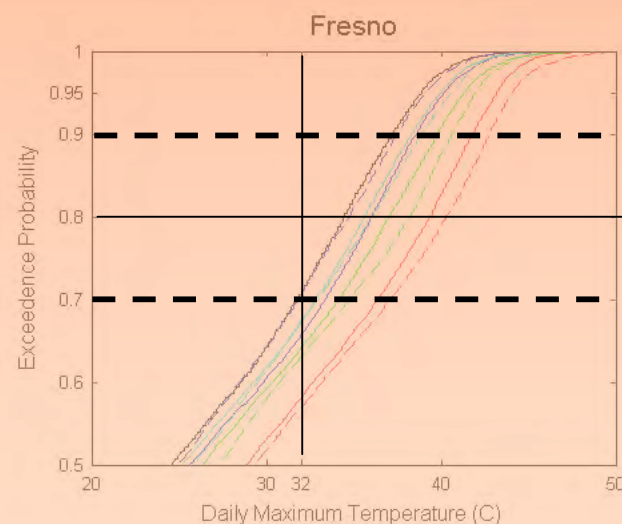
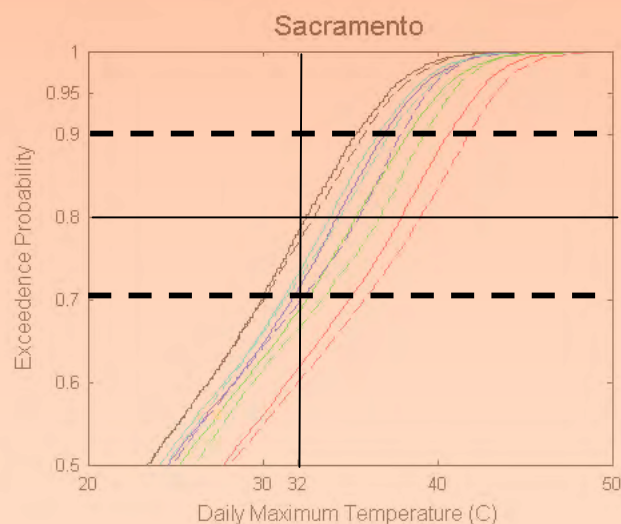
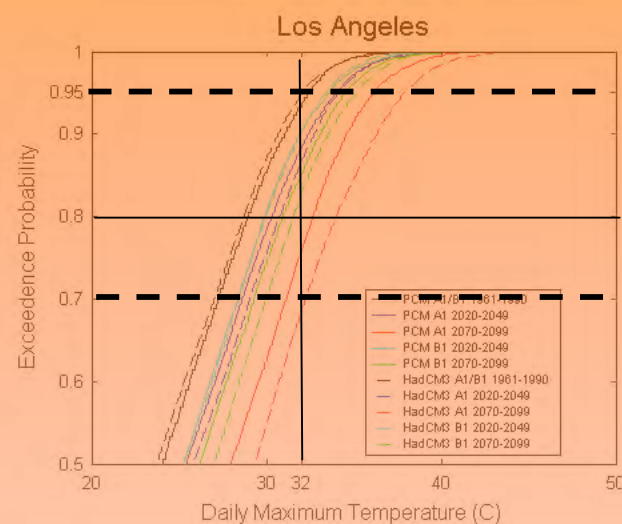
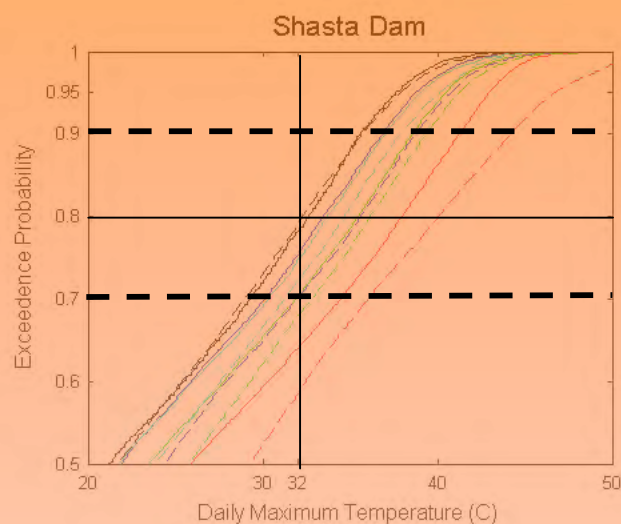


Change in California Heat Wave Onset



Change in the Number of California Heat Waves





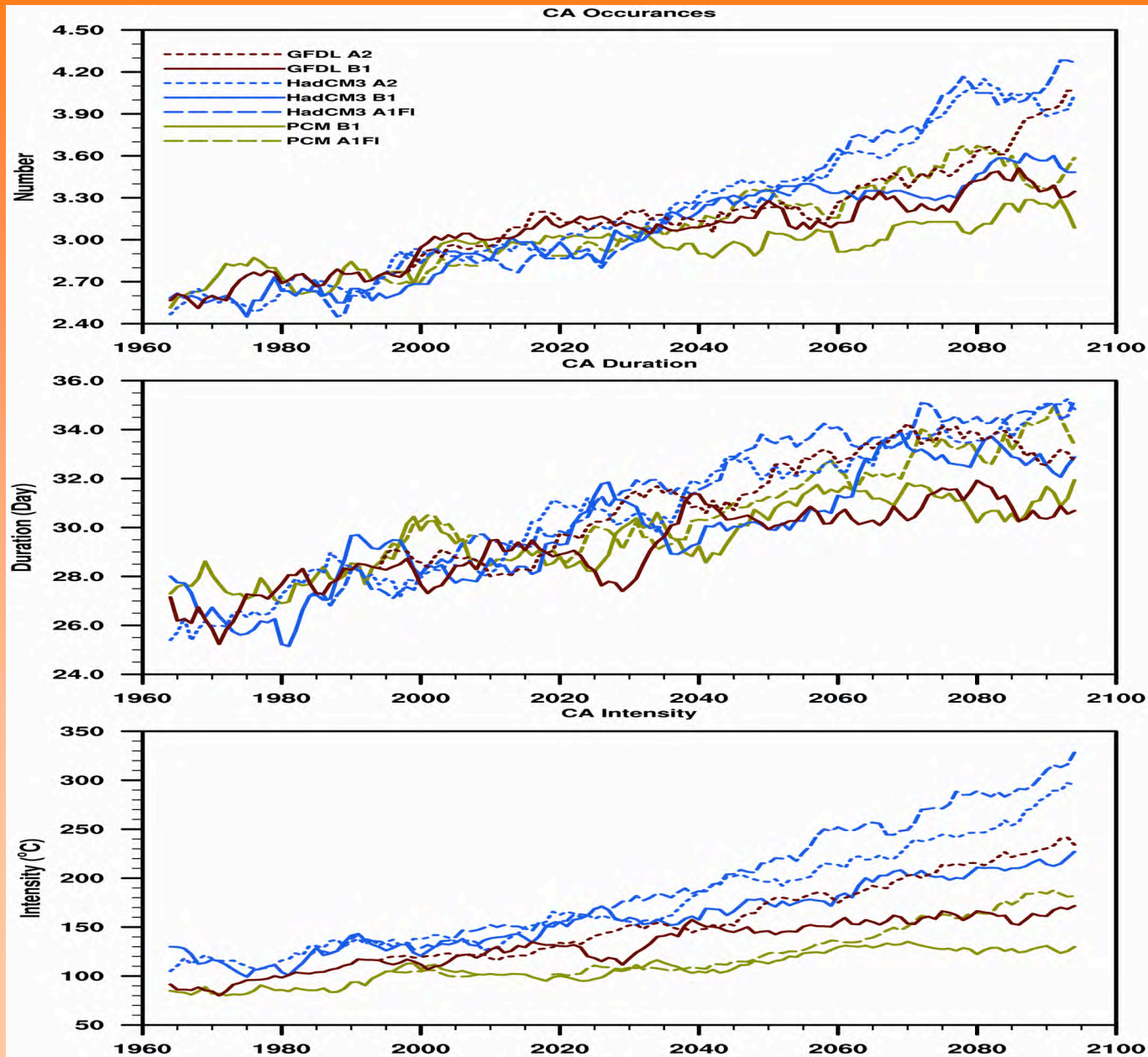
The 32°C (90°F) Heat Threshold Exceedence shifts 5-30 percent. HadCM3 (dashed) and PCM (solid) for A1fi 1961-1990 (black), 2020-2049 (blue), 2070-2099 (red), and B1 2020-2049 (light green), 2070-2099 (dark green).

Number of days with temperature at or above 90°F at ~2100

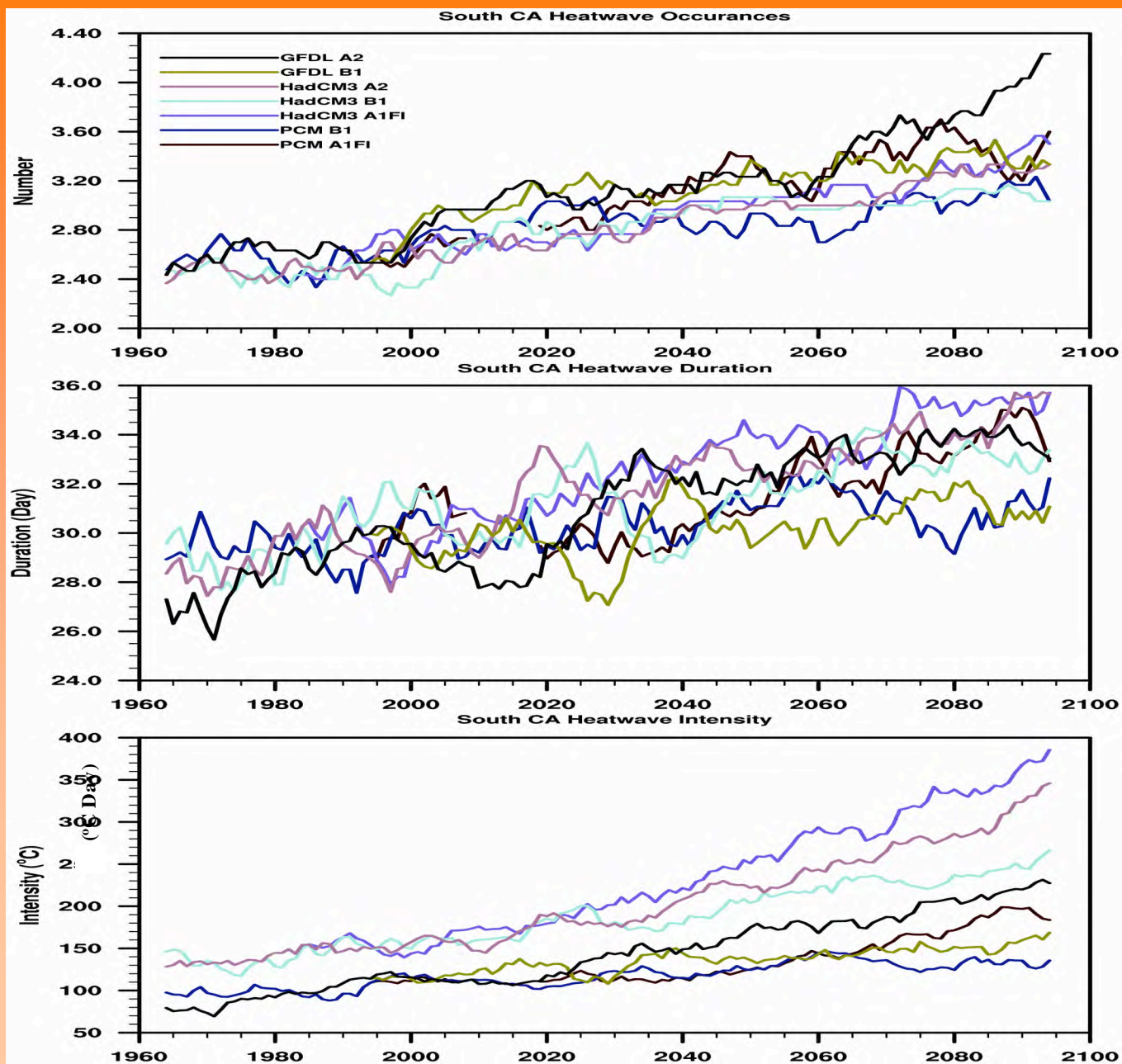
			PCM		HadCM3		PCM		HadCM3	
			B1	A1fi	B1	A1fi	B1	A1fi	B1	A1fi
1961-1990										
Los Angeles	days	12	28	35	24	36	44	76	47	95
Sacramento	days	58	91	101	93	104	109	134	115	138
Fresno	days	92	113	120	111	116	126	147	126	149
El Centro	days	162	185	185	176	180	191	213	197	218

Miller et al. 2004

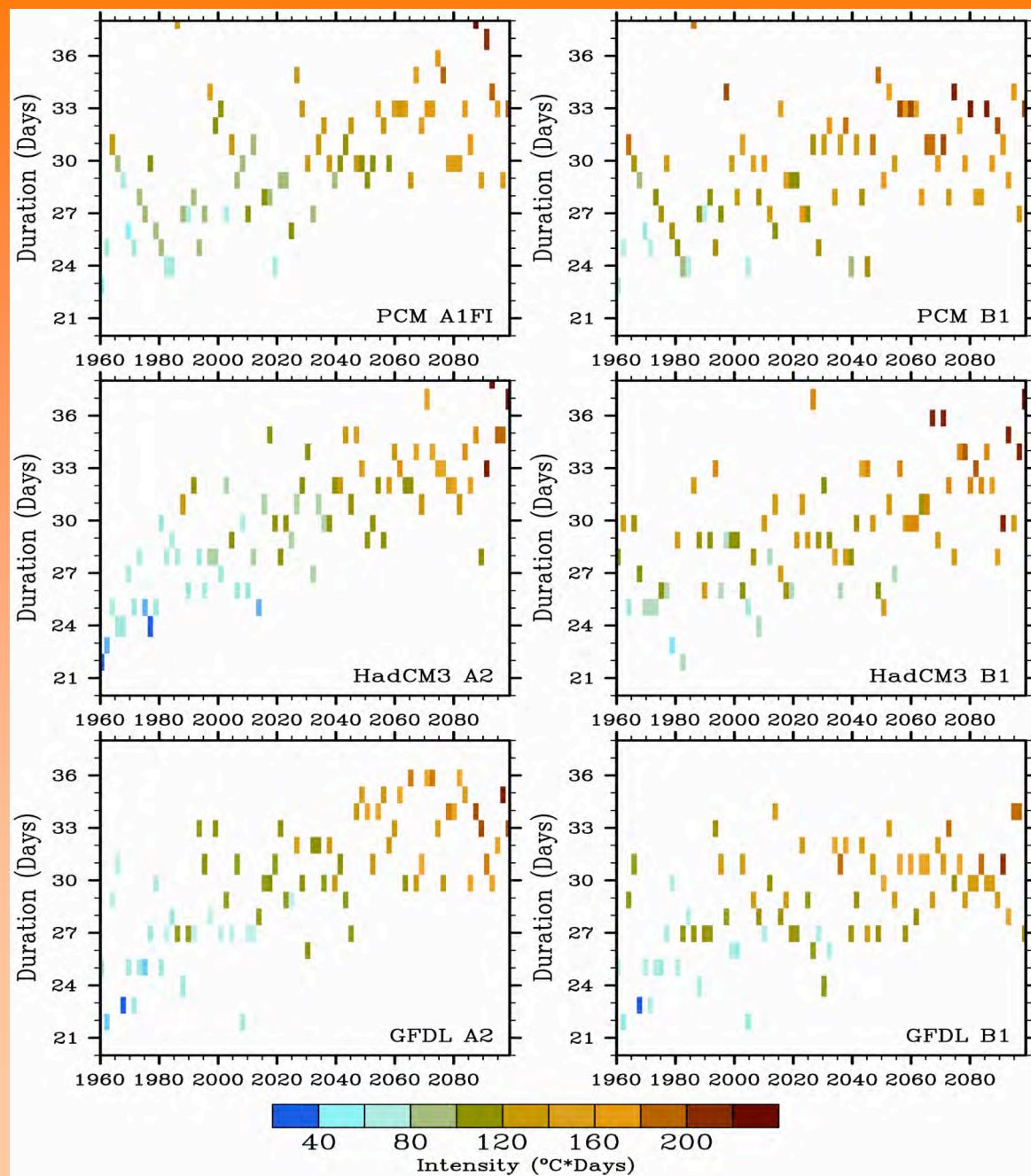
California 80 Percentile Heat Occurrence-Intensity-Duration



Southern California 80 Percentile Heat Occurrence-Intensity-Duration



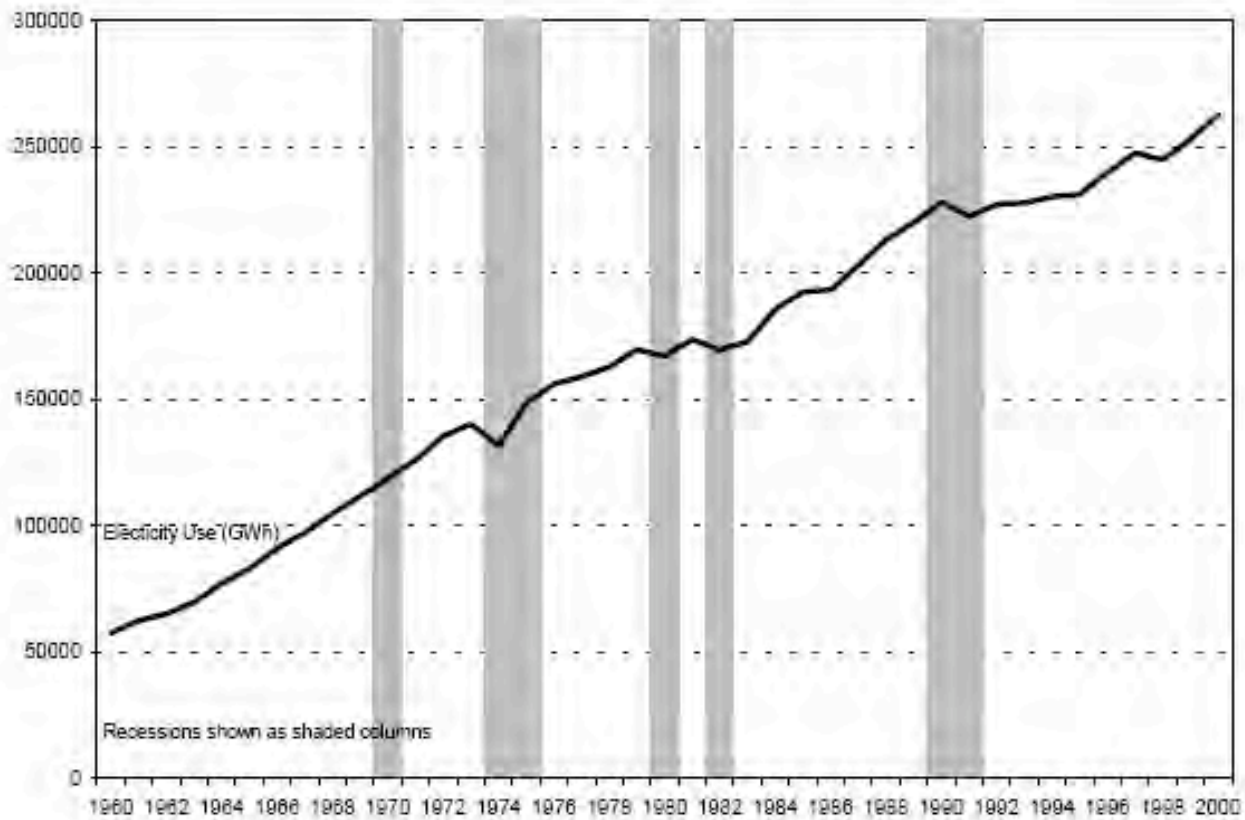
California Heat Duration-Intensity for 3 GCMs, 3 Emissions



Projected Energy Demand

- Present world demand for energy is approximately equivalent to a continuous power consumption of 13 trillion watts (i.e. 13 TW).
- With aggressive conservation and energy efficiency, an expected global population of 9 billion accompanied by rapid technology growth is projected to more than double energy demand to 30 TW by 2050 and to more than triple this demand to 46 TW by 2099
- California energy demand is on an upward trend with future summer demand due to high temperature approaching 65 GW by 2010.

Figure II-1-4
California Electricity Use is Influenced by Economic Conditions



California Electricity Consumption for 1990 - 2016

Figure 1-1: Statewide Electricity Consumption

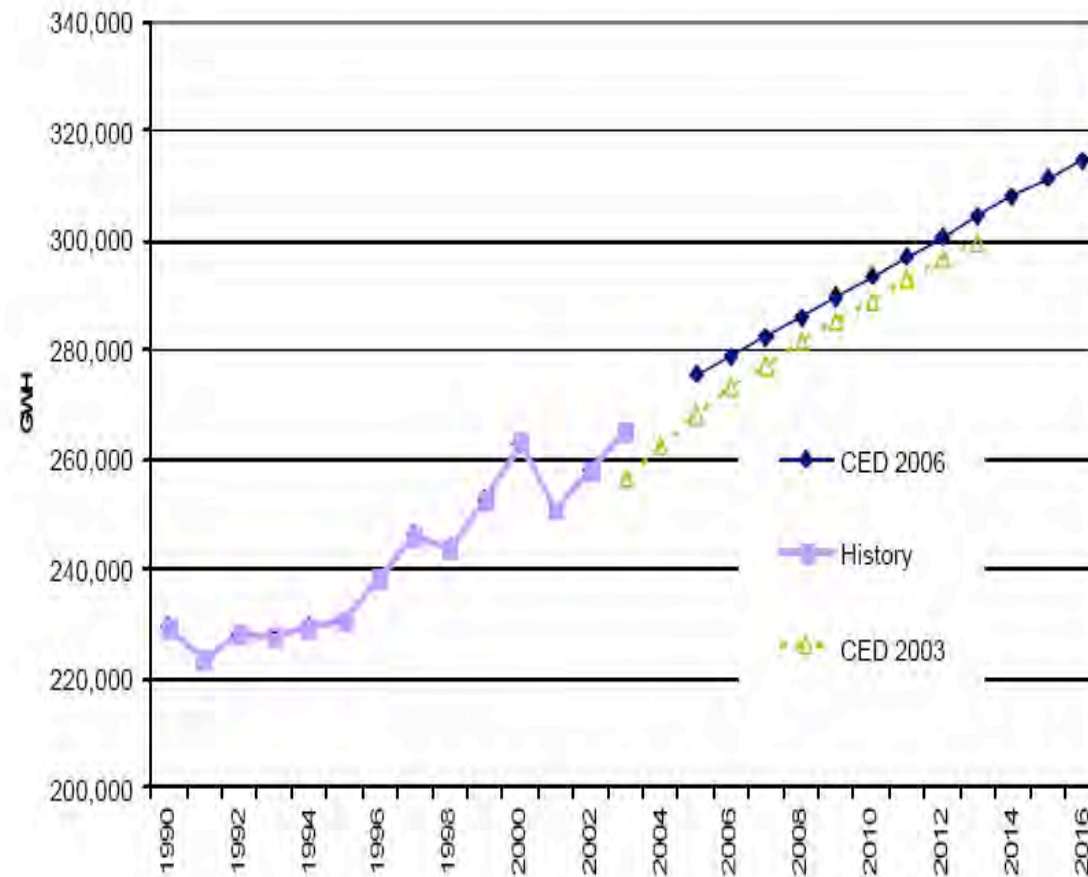
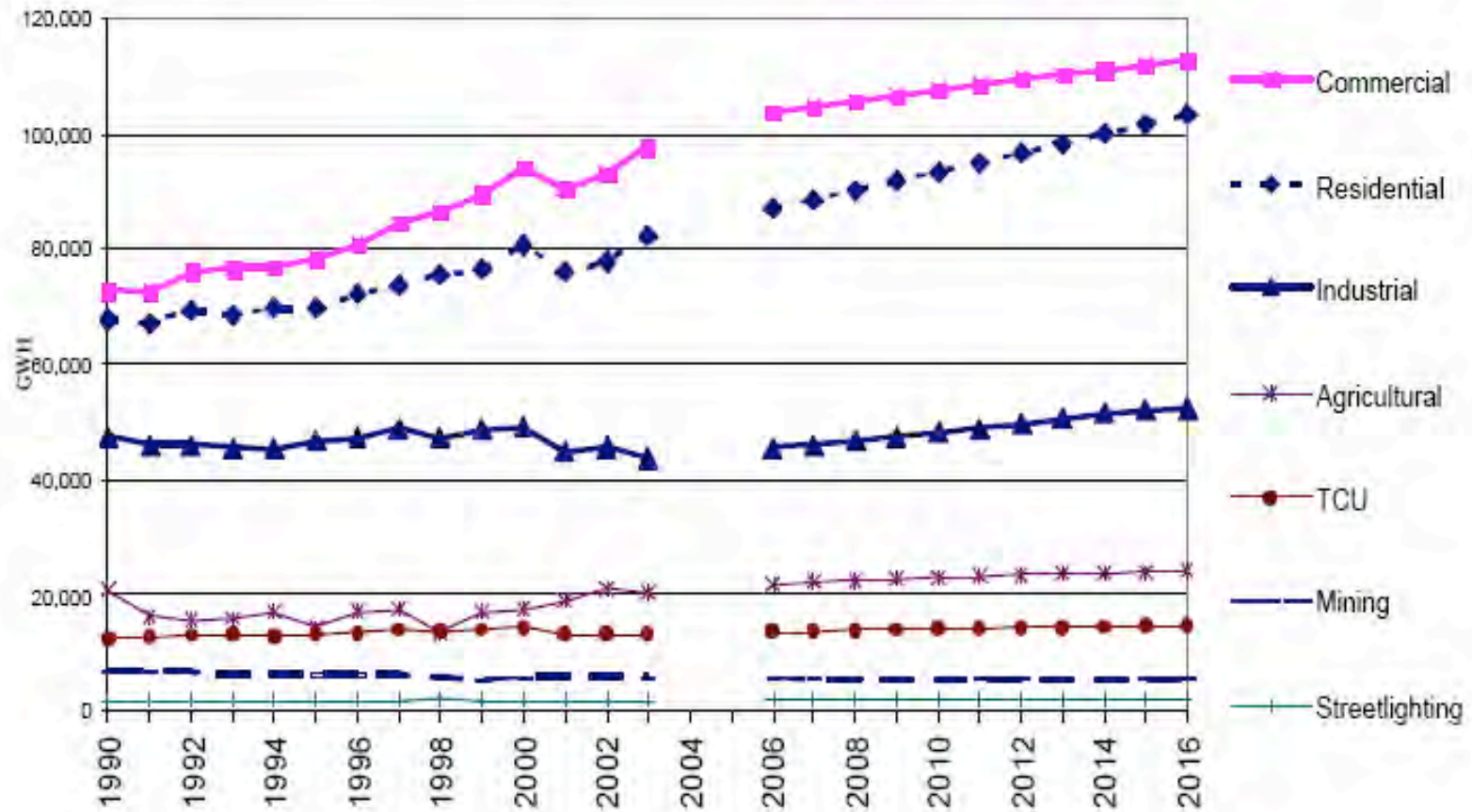
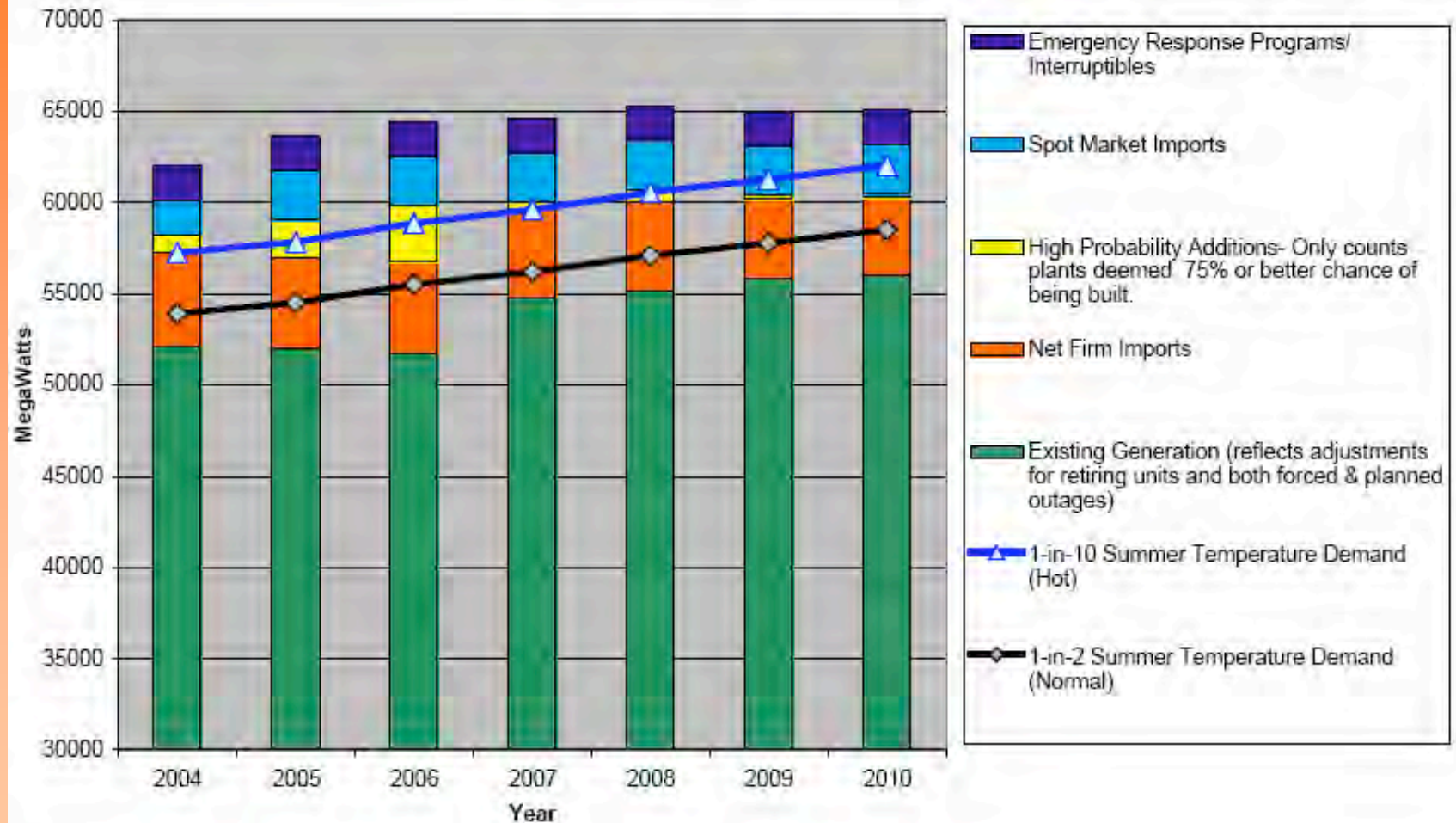


Figure 1-3: Statewide Electricity Consumption by Sector



CEC Report 2005

Figure 3
2004-2010 Statewide
Electricity Supply/Demand Outlook
 California Energy Commission



Population-weighted average temperature on California Electrical Load for 17-20 July 2001

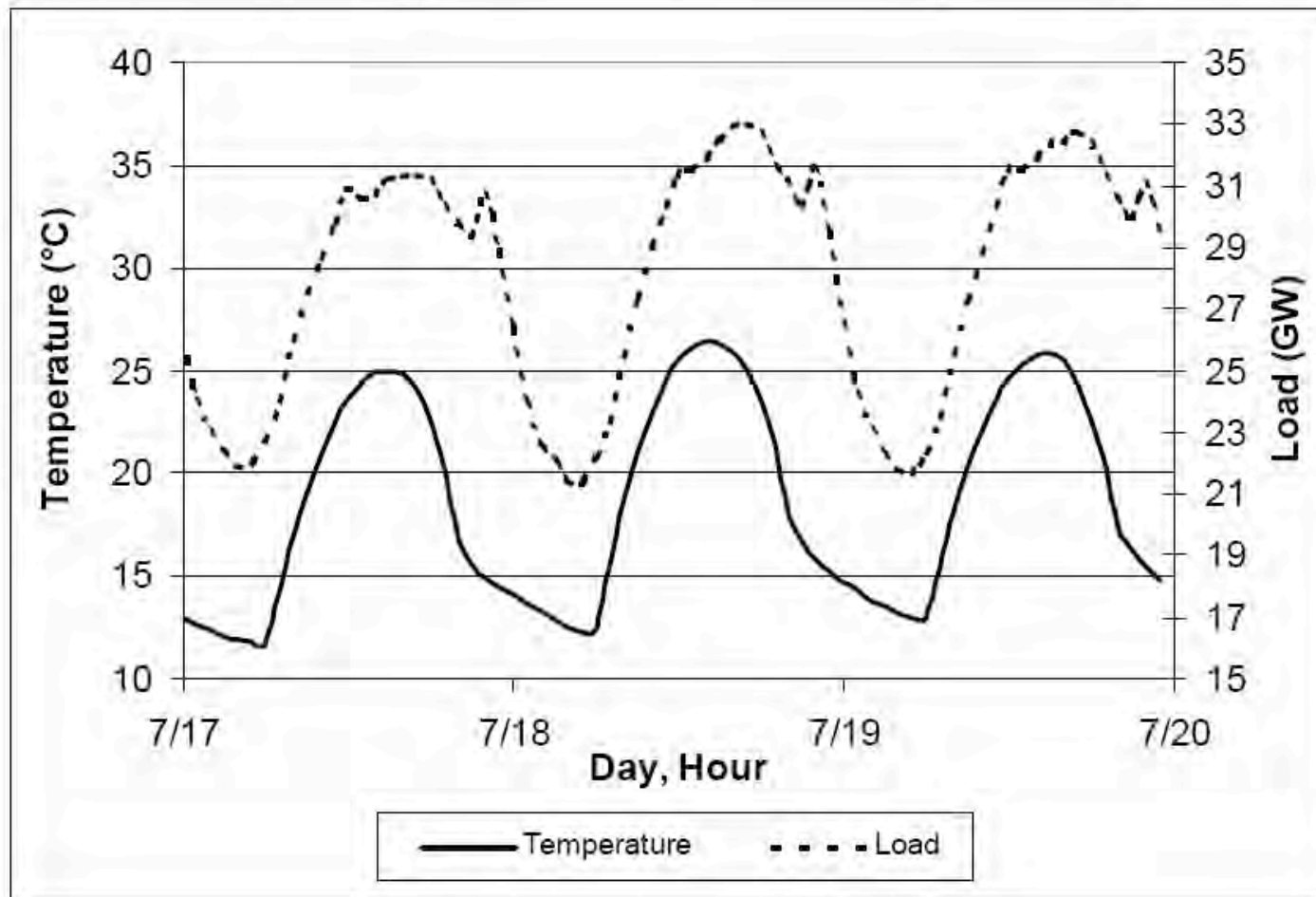


Figure 1. Load and temperature, July 17 - 20

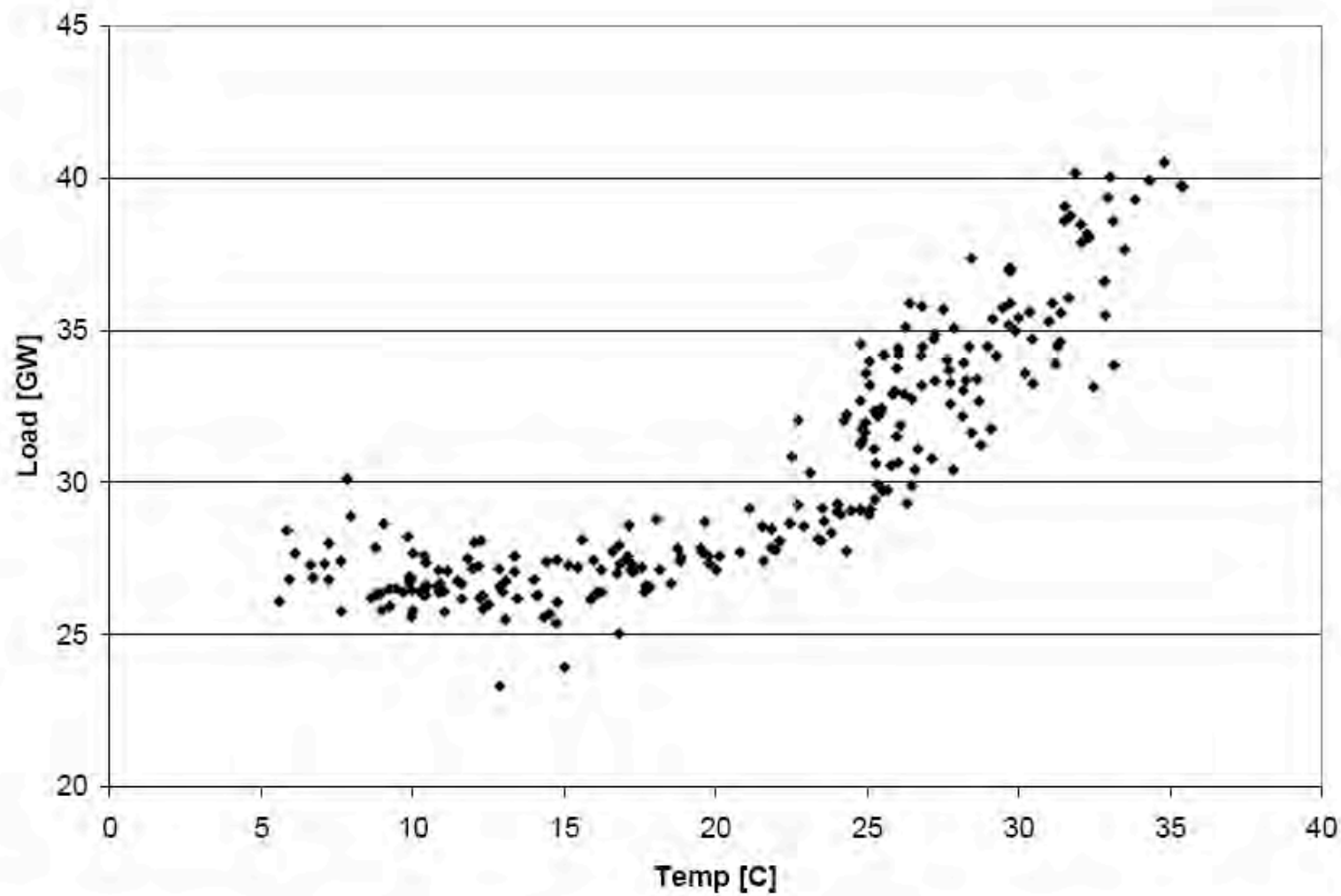


Figure 3. Load (recorded on Weekdays, Hour 16, Year 2001 with natural light present) vs. Temperature

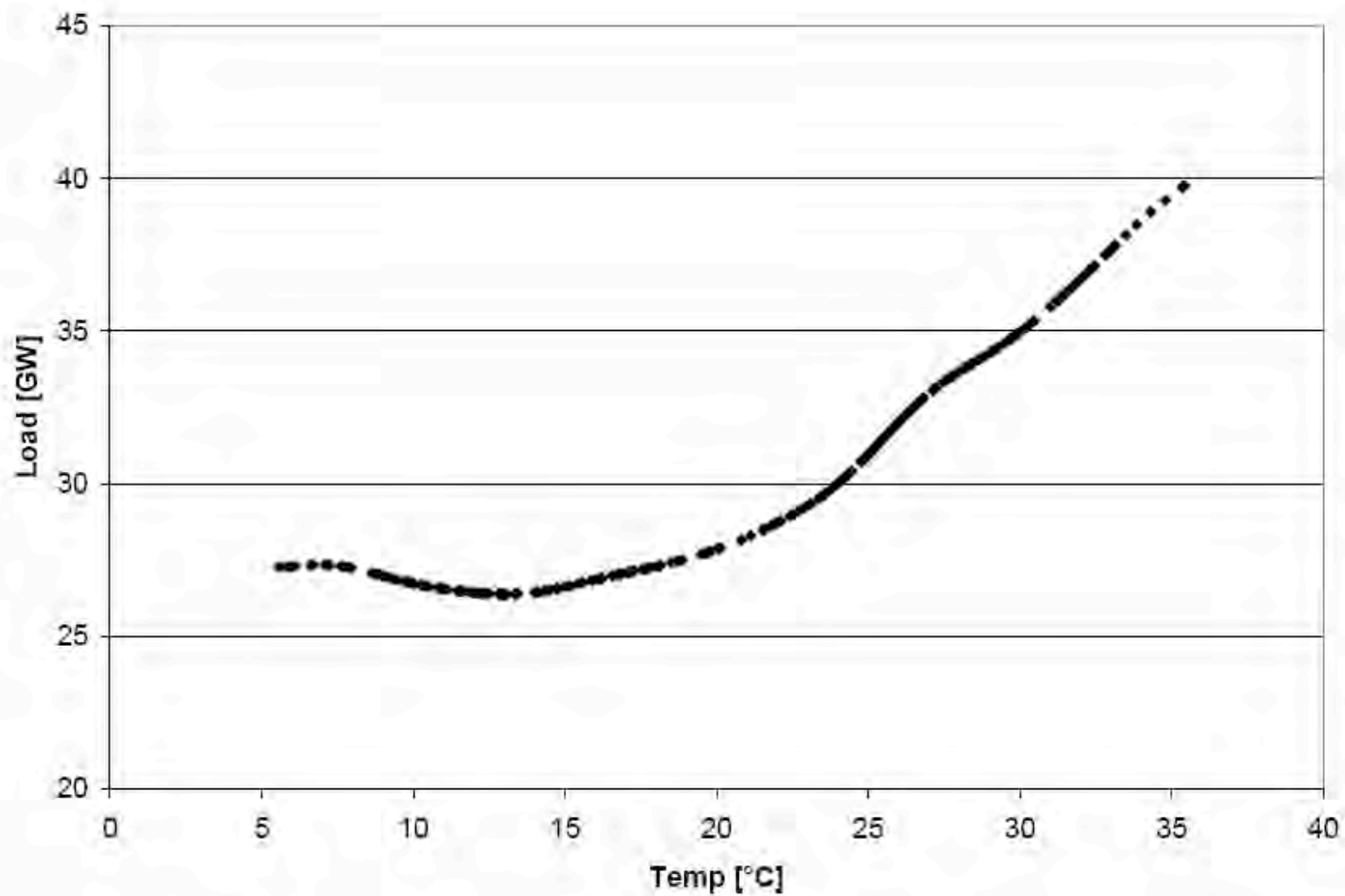
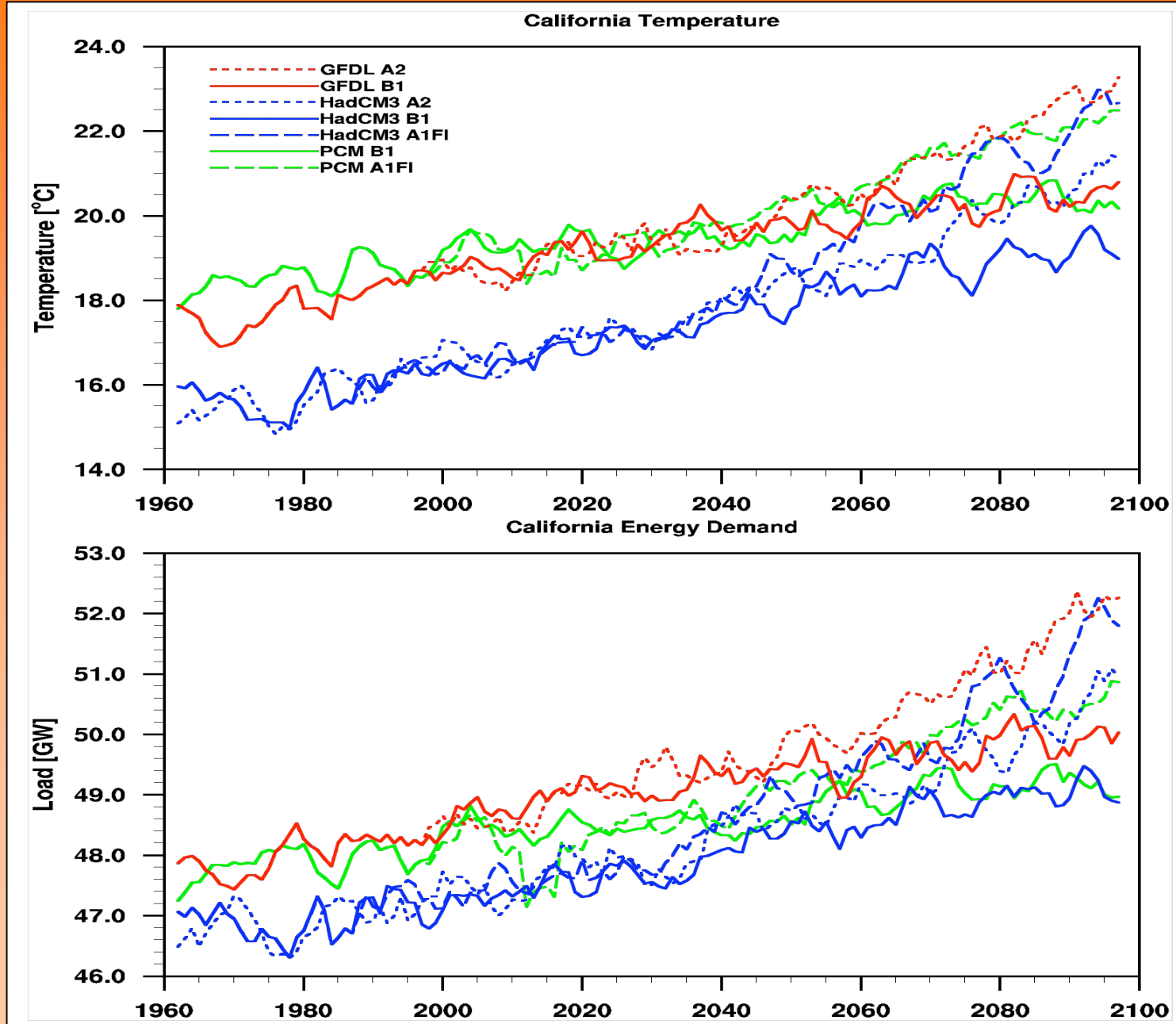
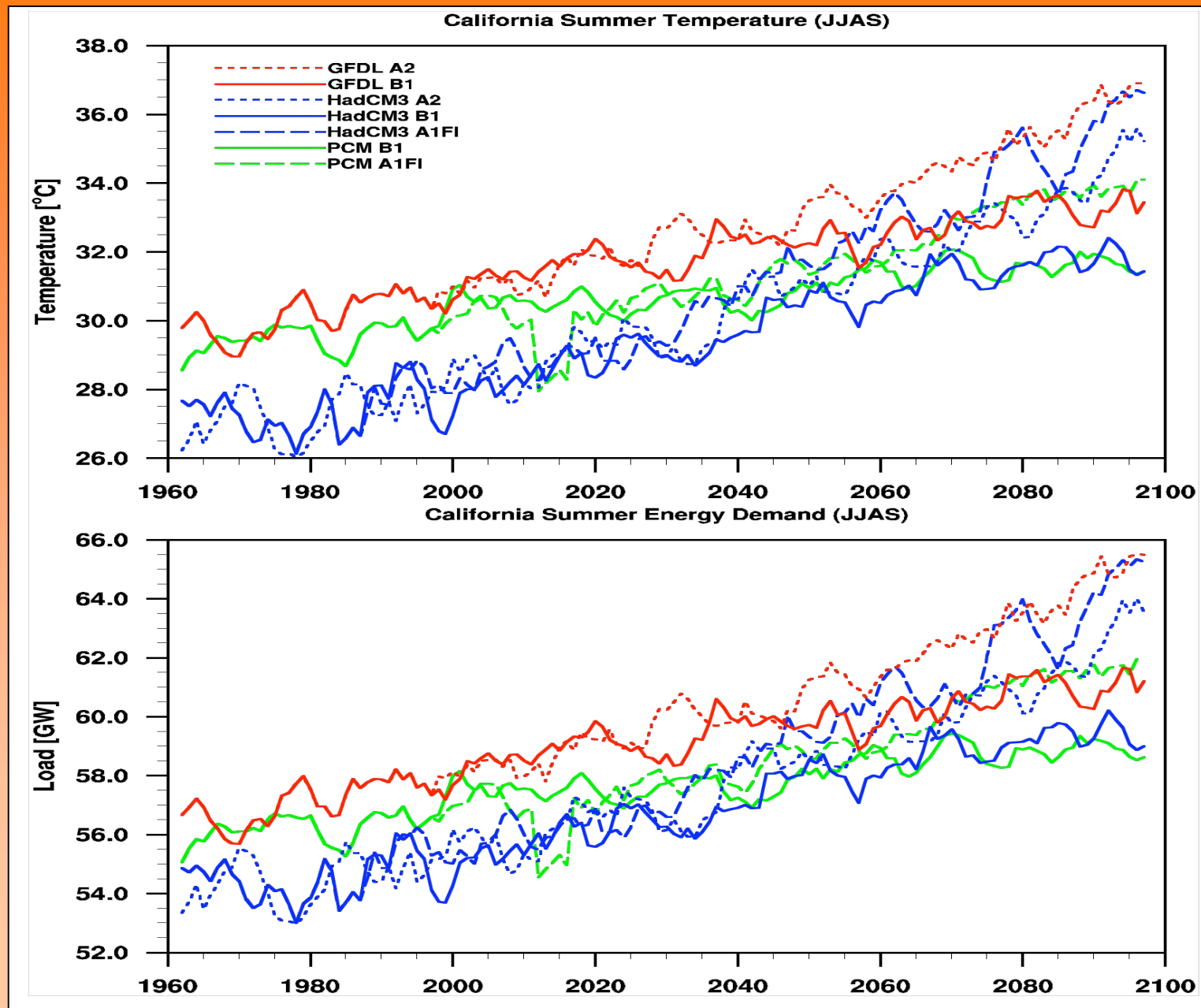


Figure 4. Smoothed Load (recorded at Hour 16, Year 2001) vs. Temperature

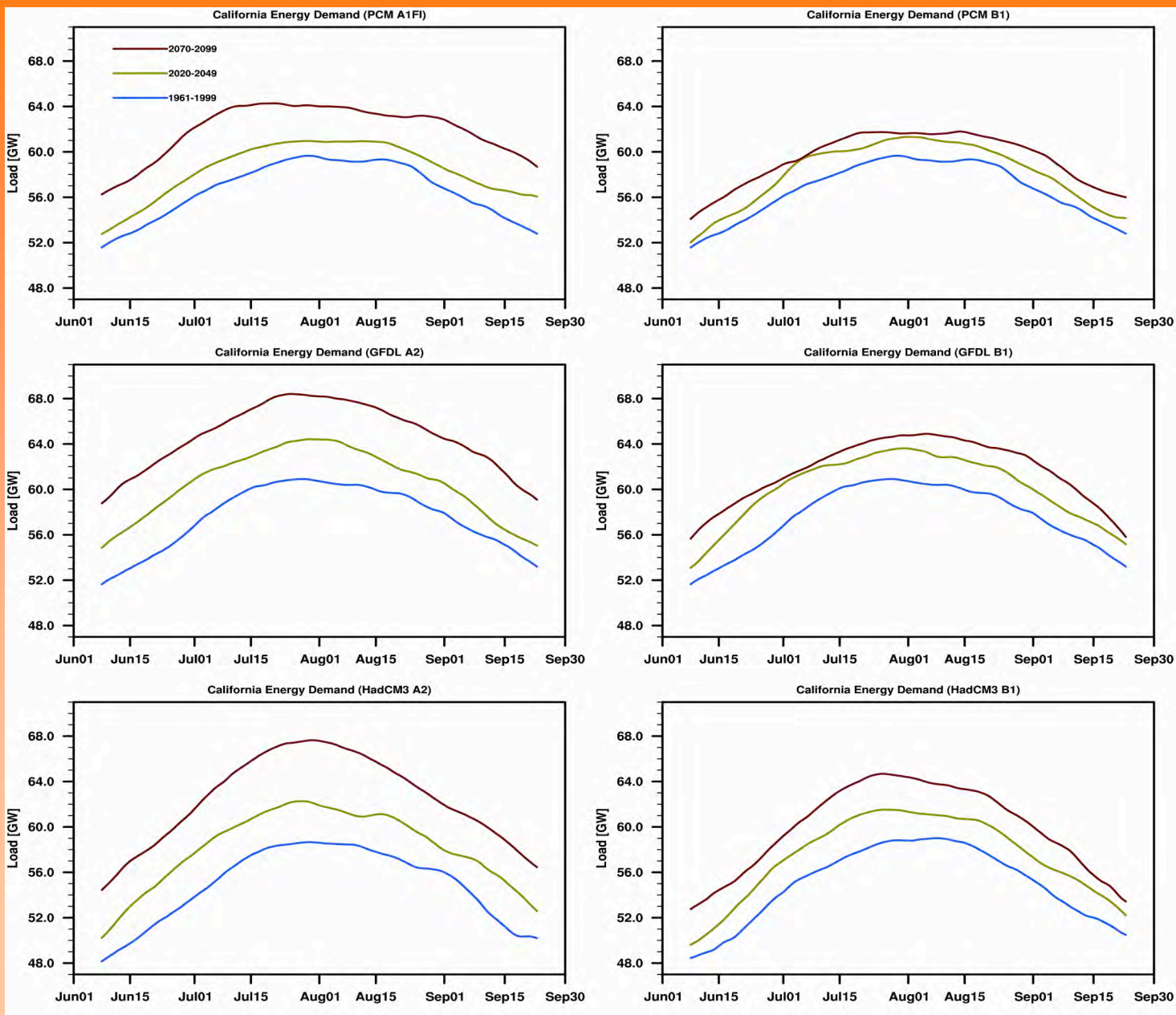
California Mean Annual Maximum Temperature and Energy Load



California Mean-Summer Maximum Temperature and Energy Load

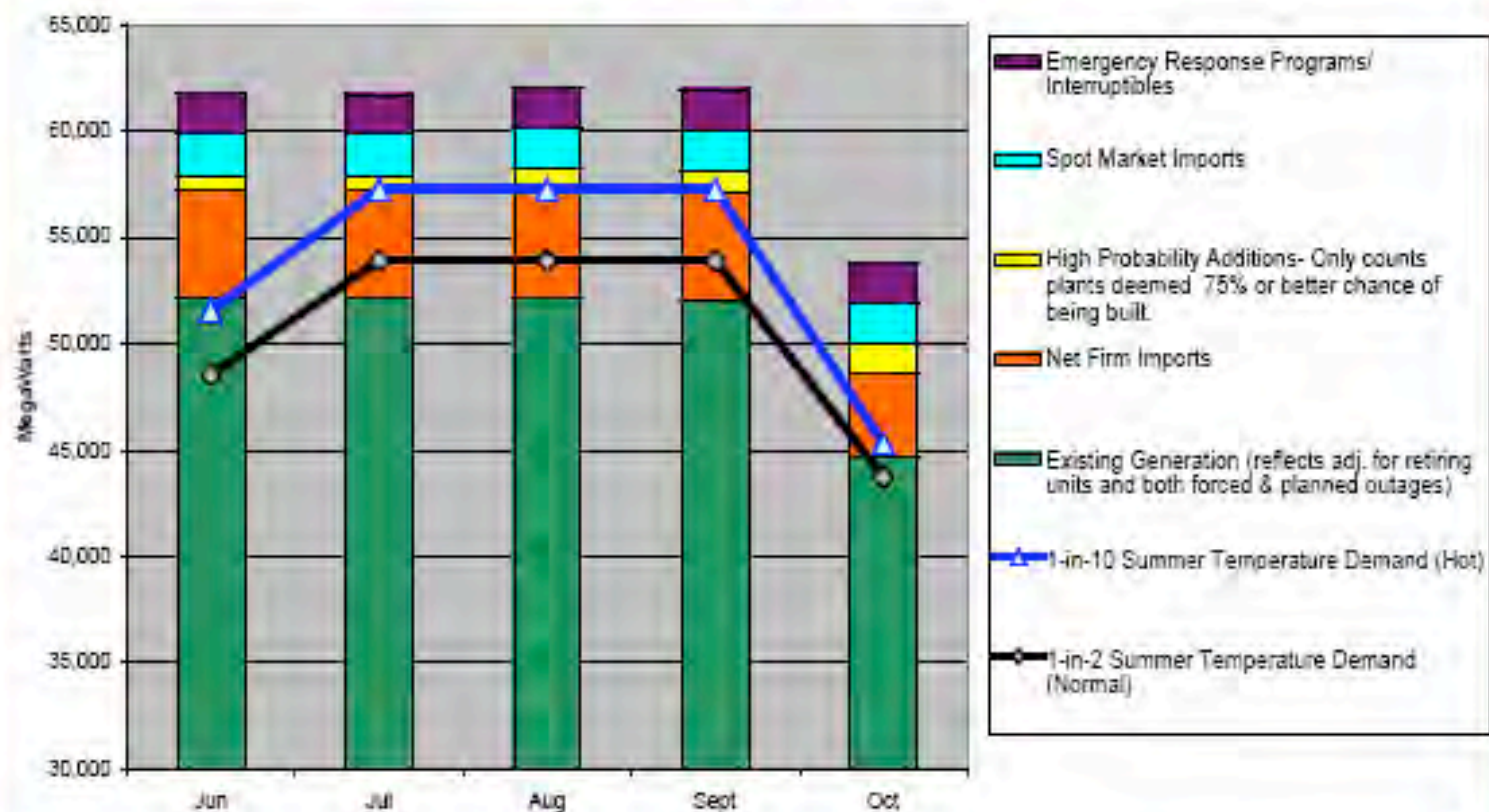


California *Climatological* Daily Energy Demand



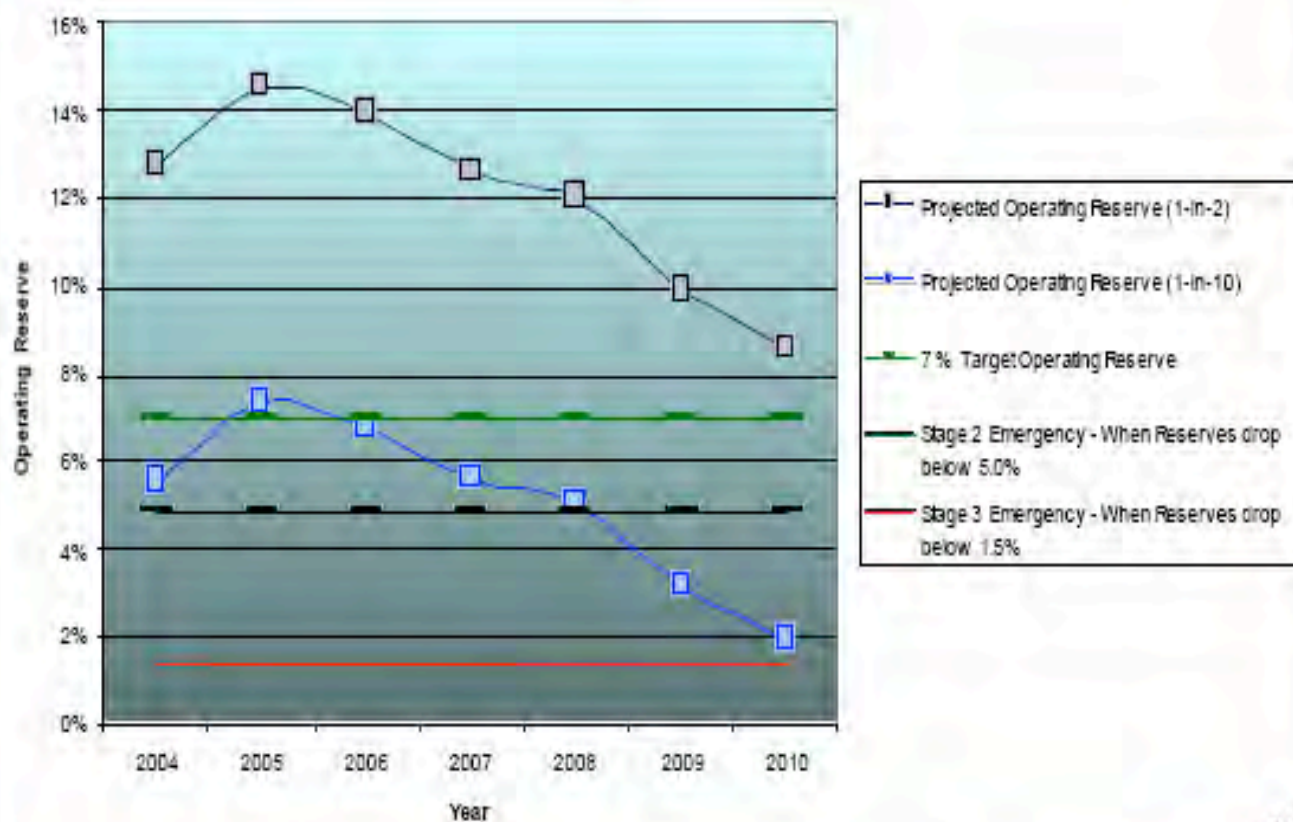


California Statewide Electricity Supply/Demand Outlook Summer 2004





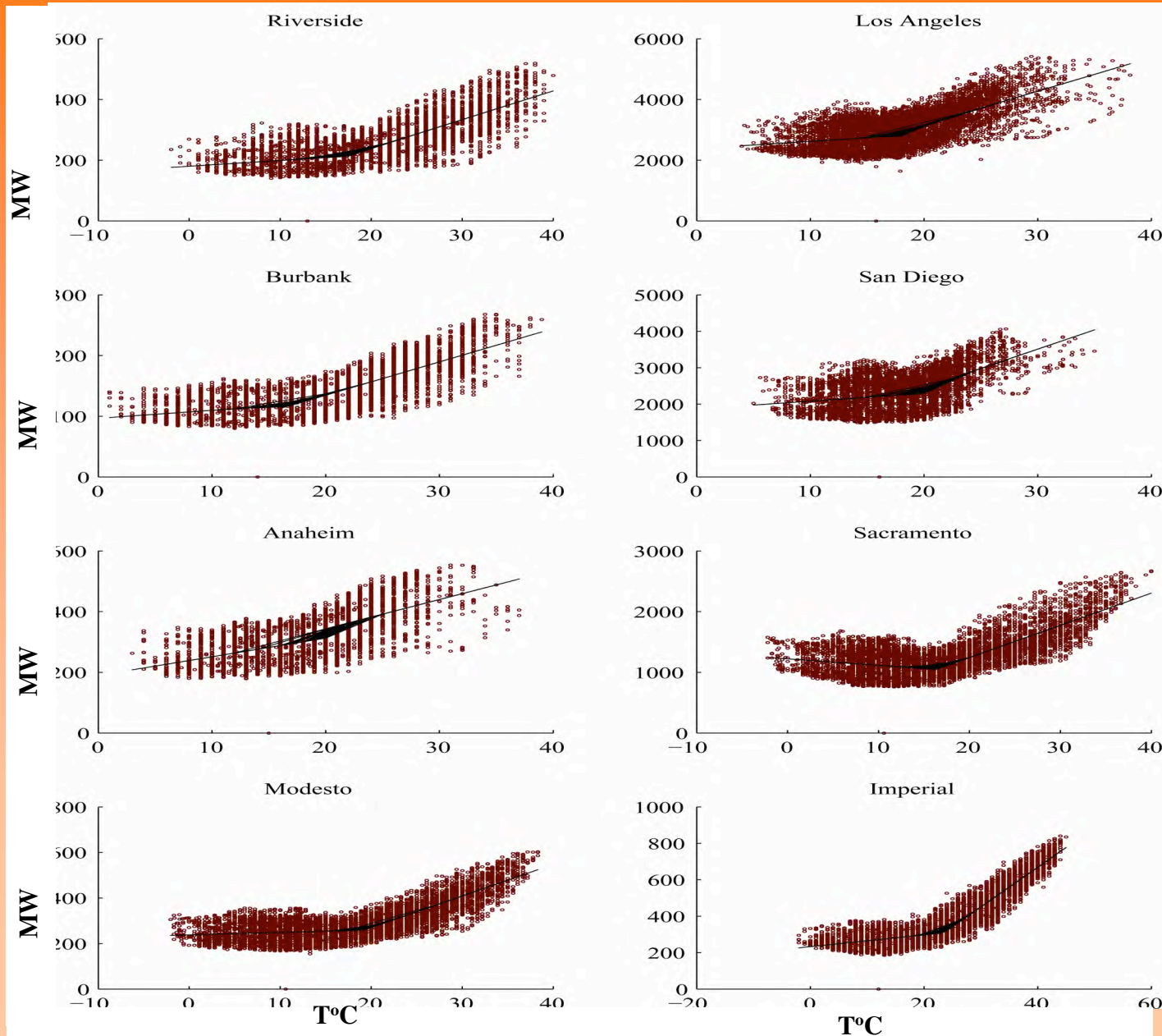
Projected Operating Reserves



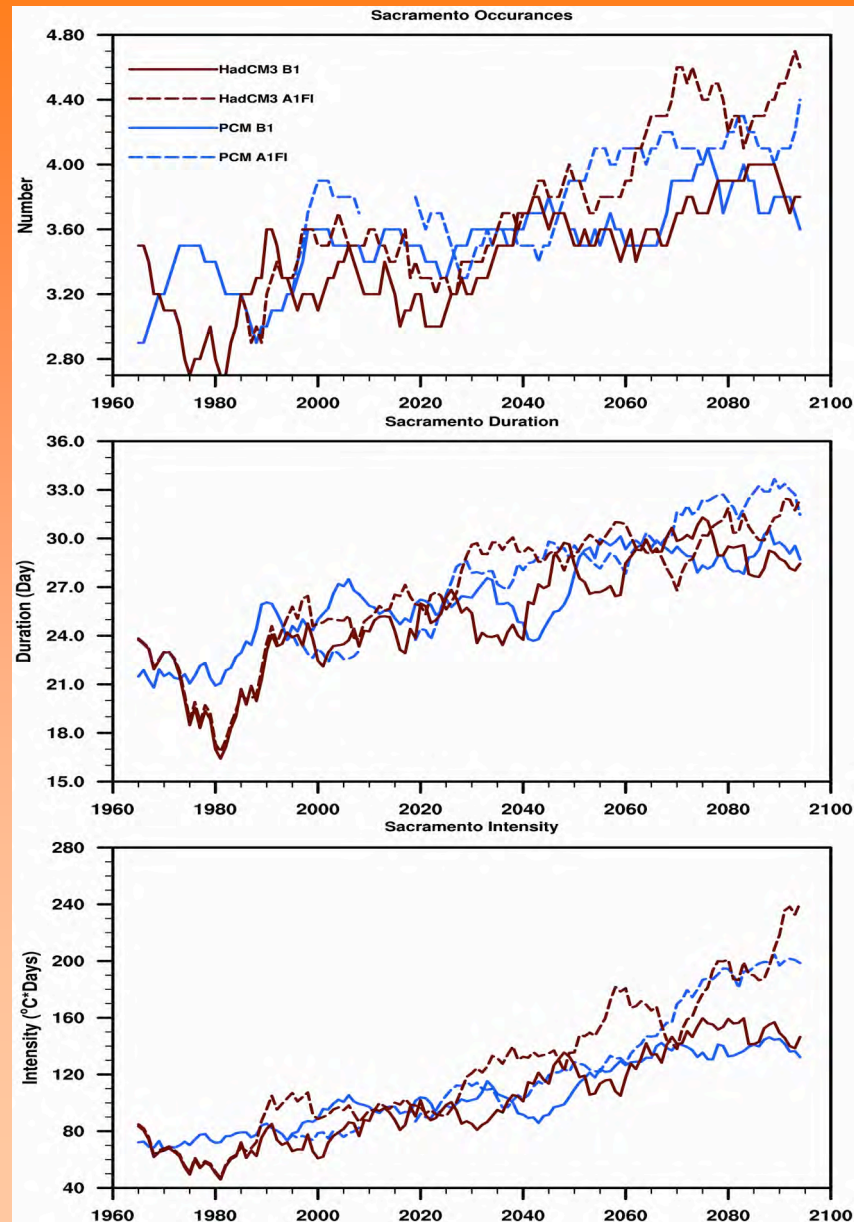
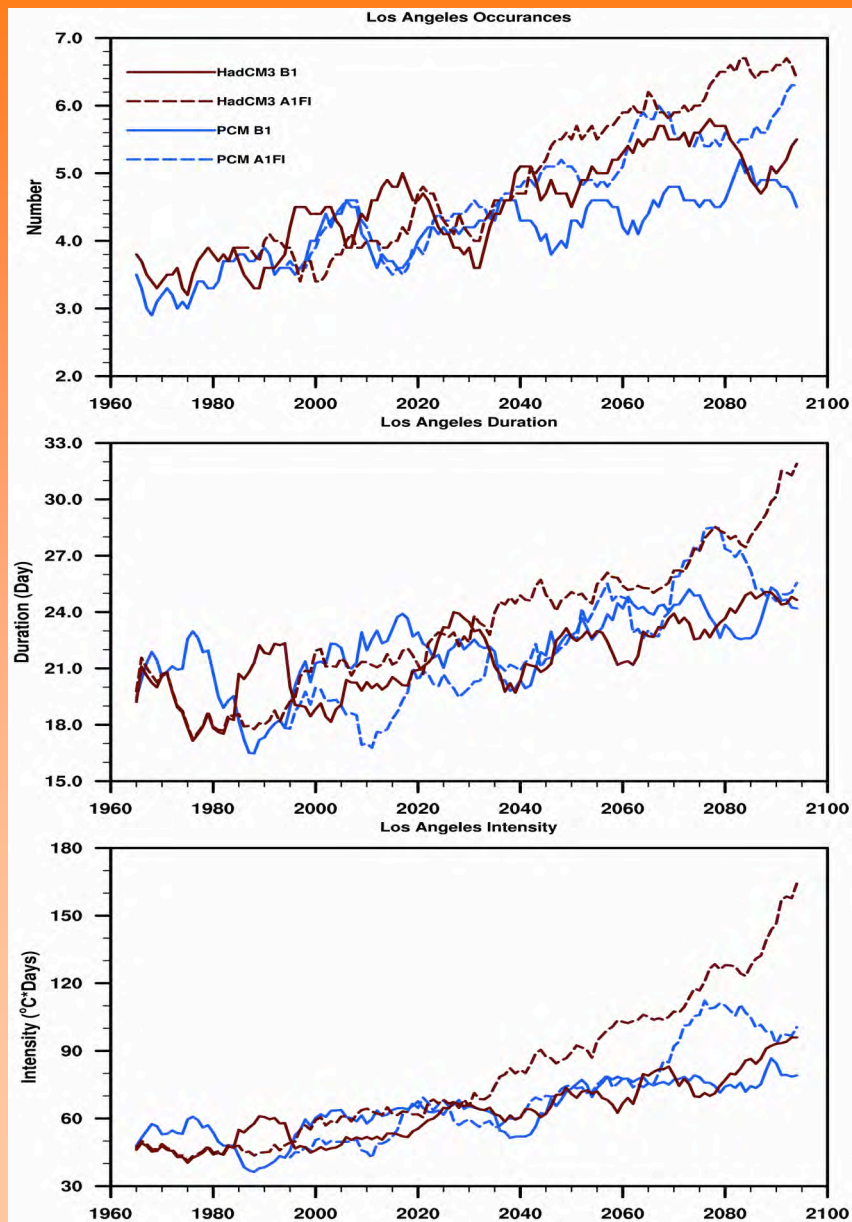
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CALIFORNIA ENERGY COMMISSION

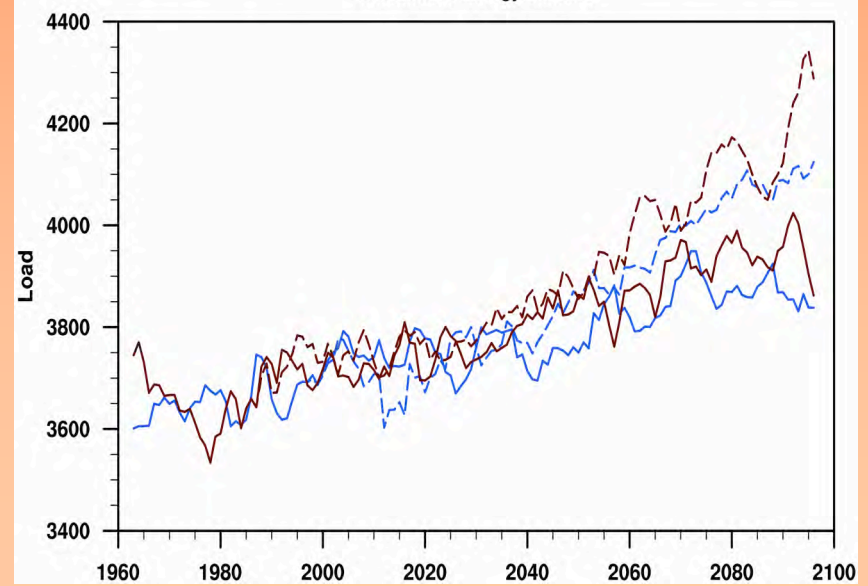
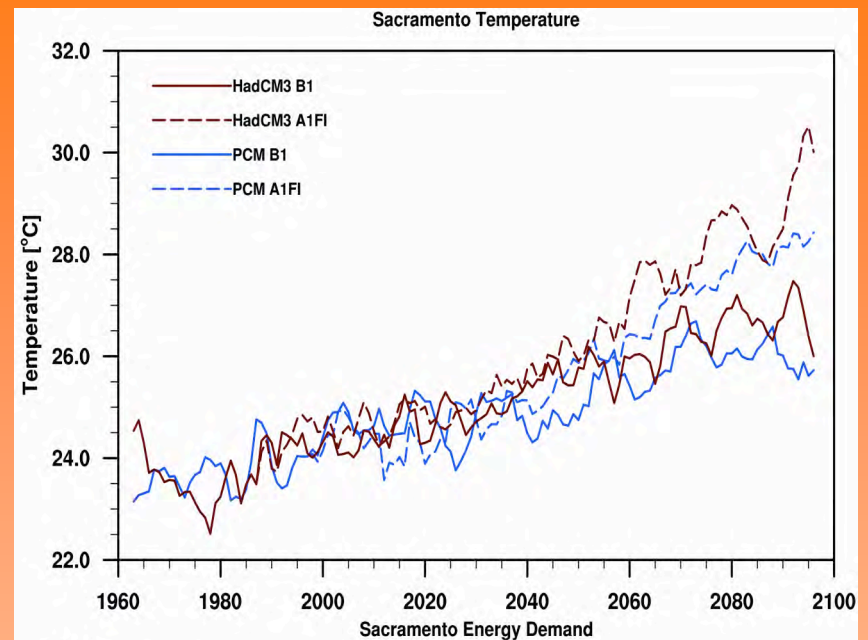
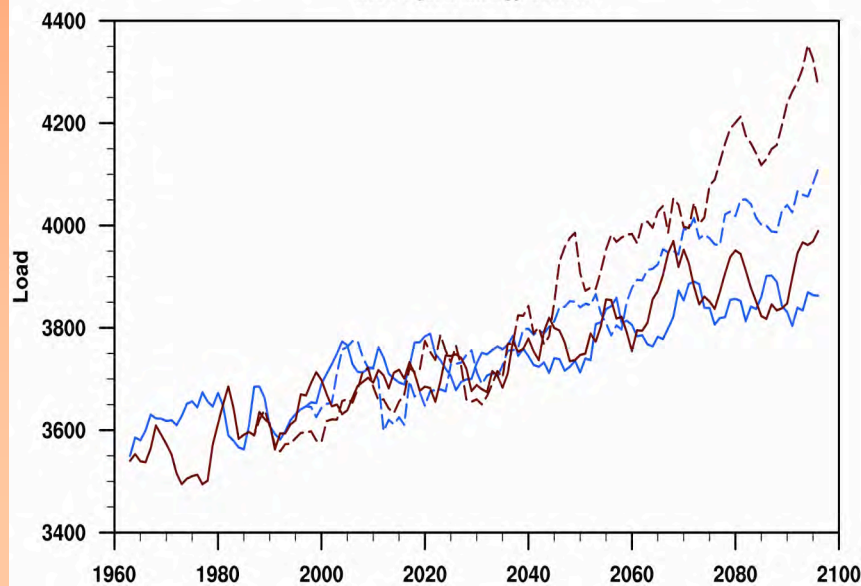
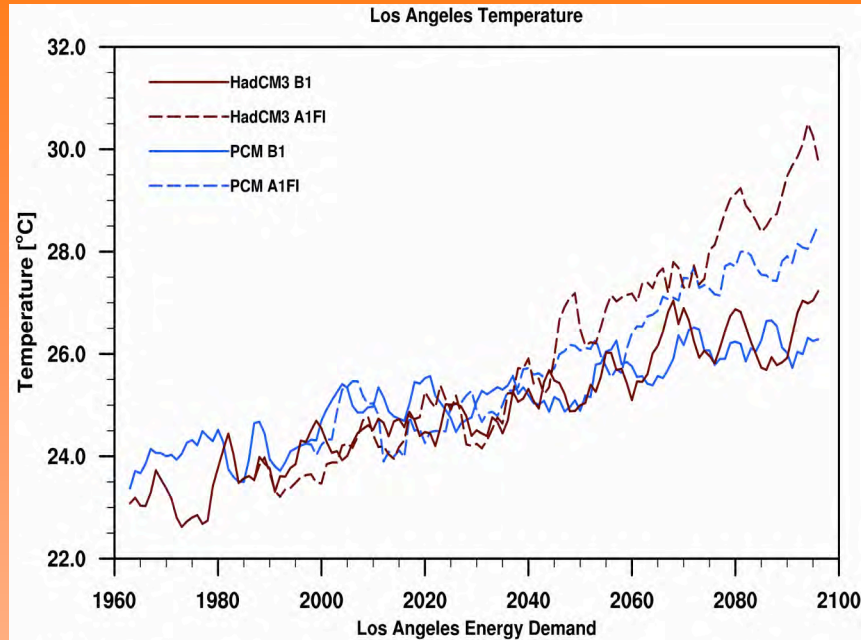
Site-Specific Energy Demand -Temperature Correlations



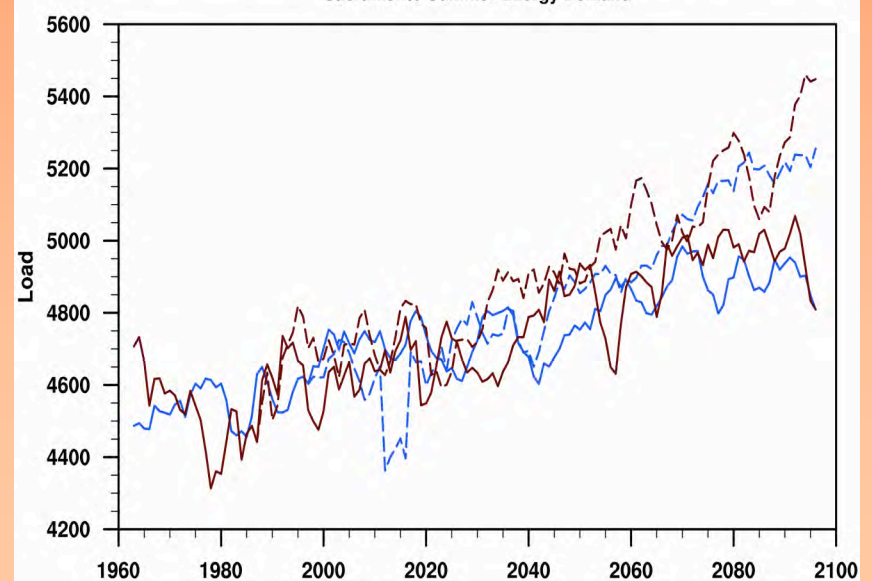
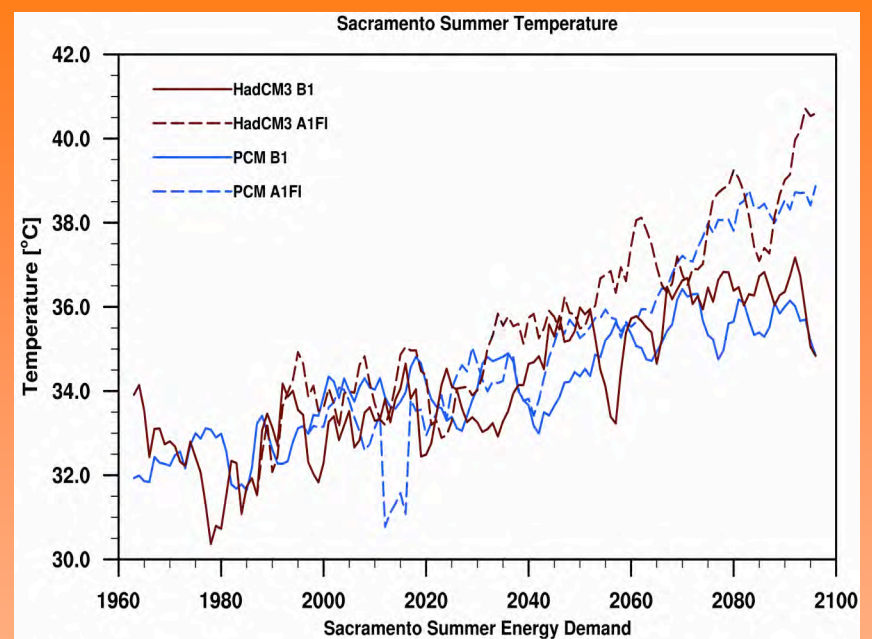
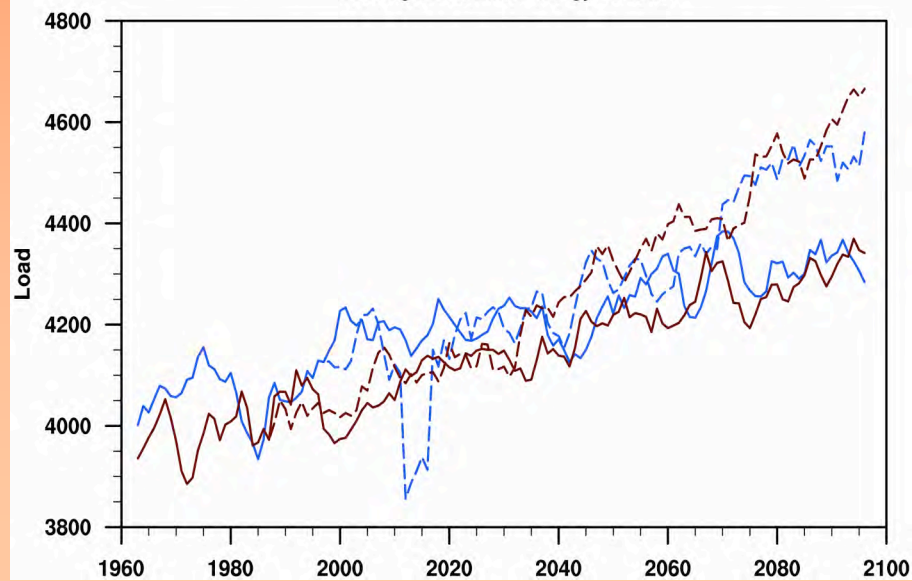
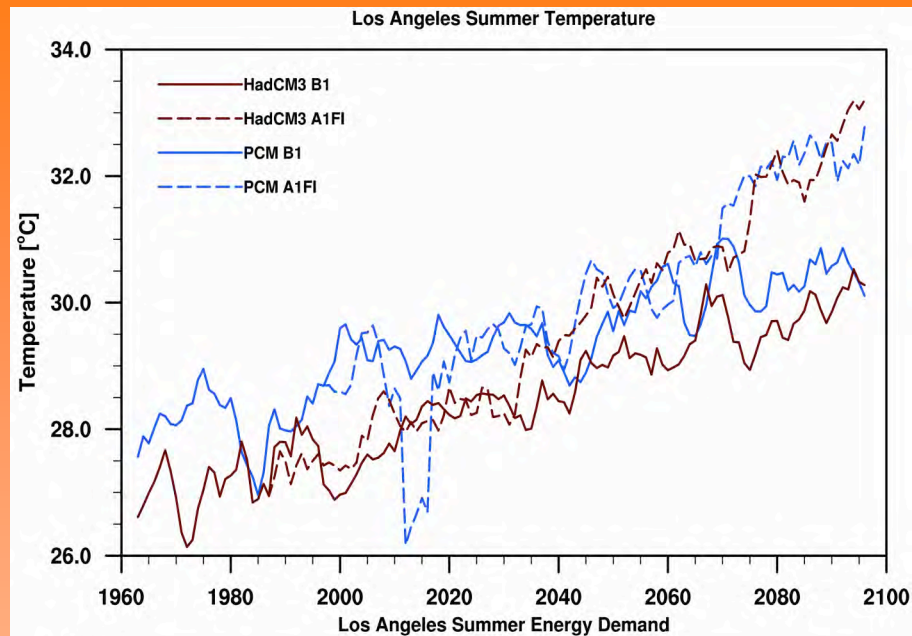
80 Percentile Heat Occurrence, Duration, Intensity



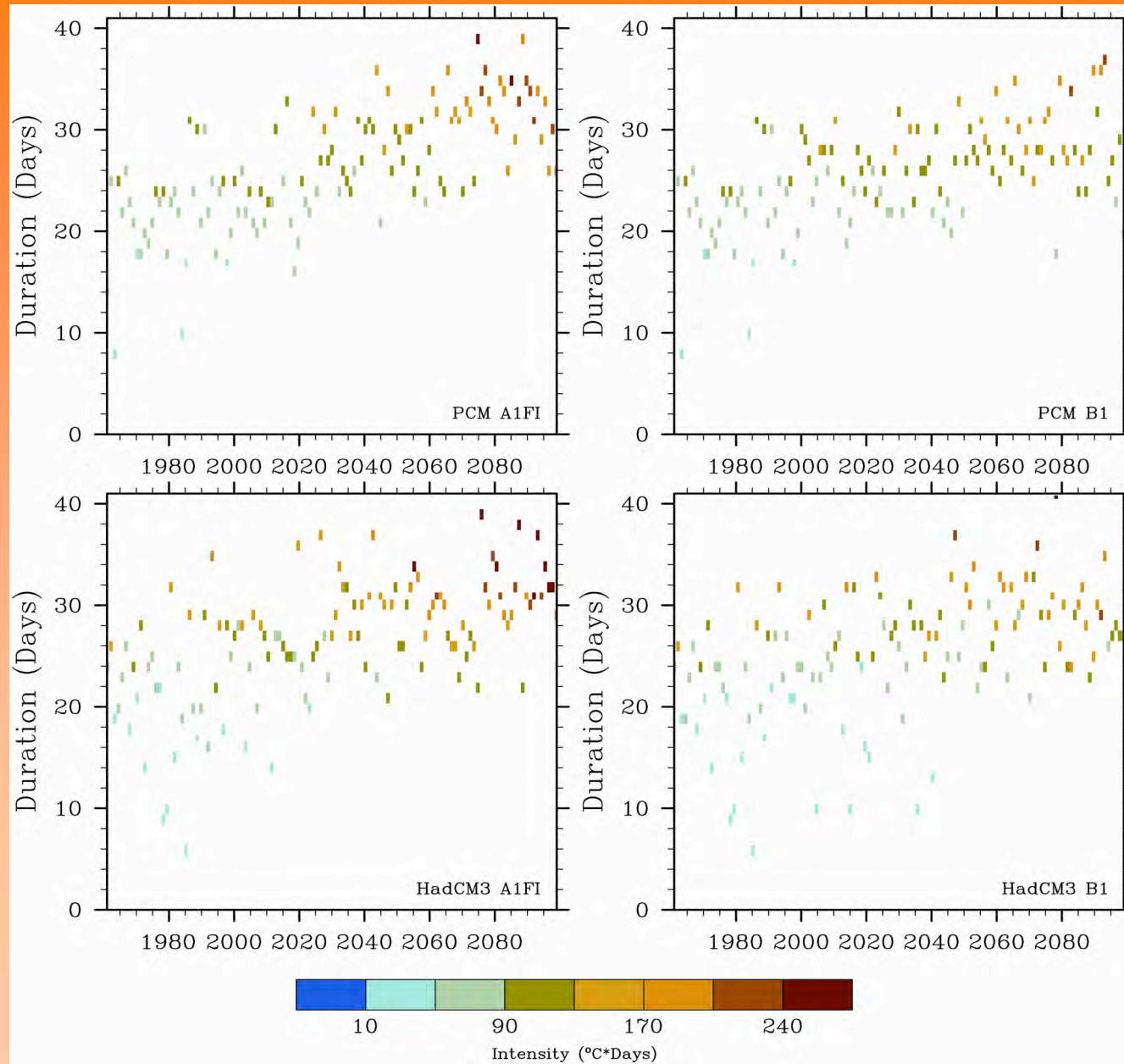
Mean Annual Temperature and Energy Load



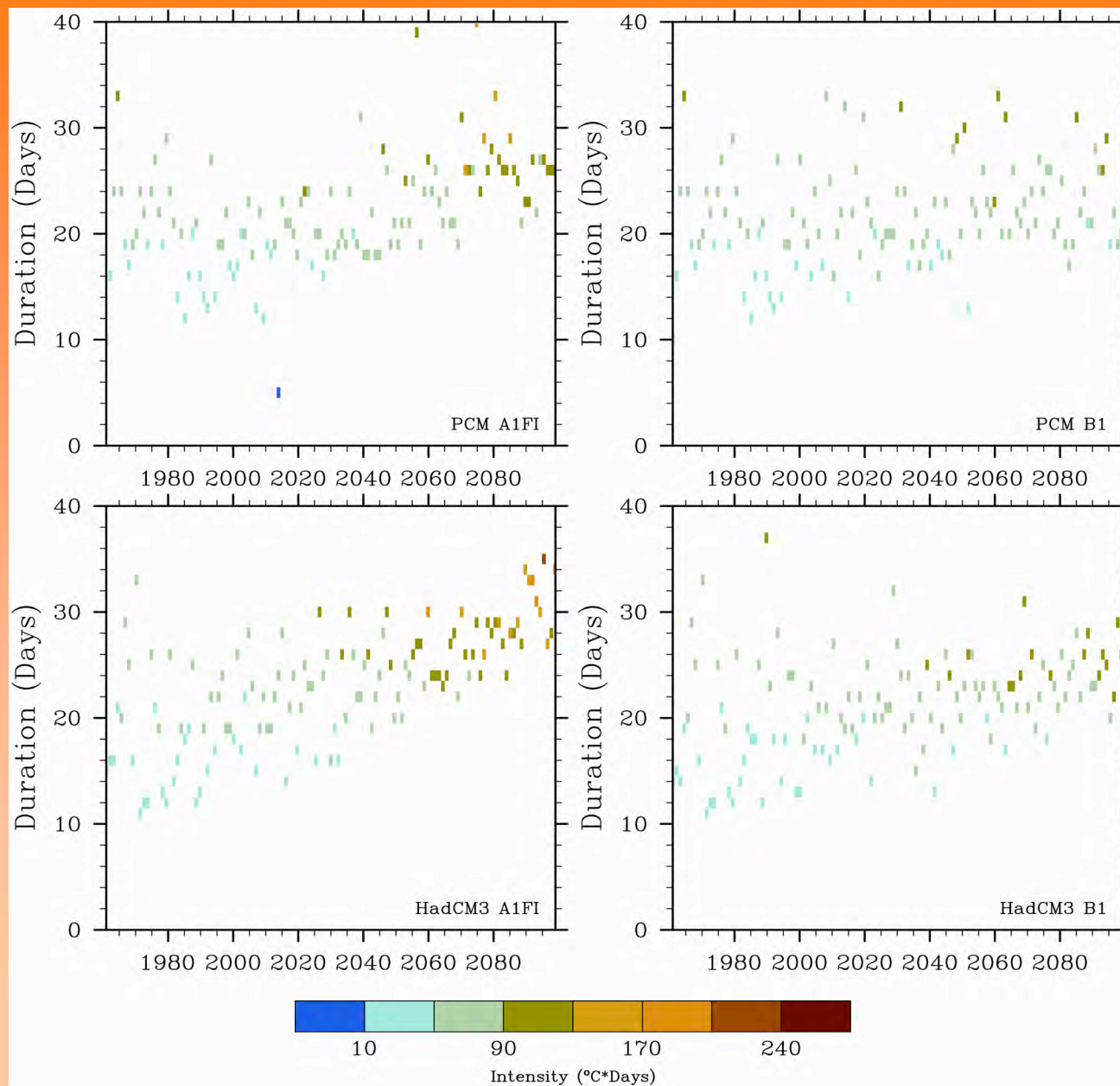
Mean Summer (JJAS) Temperature and Energy Load



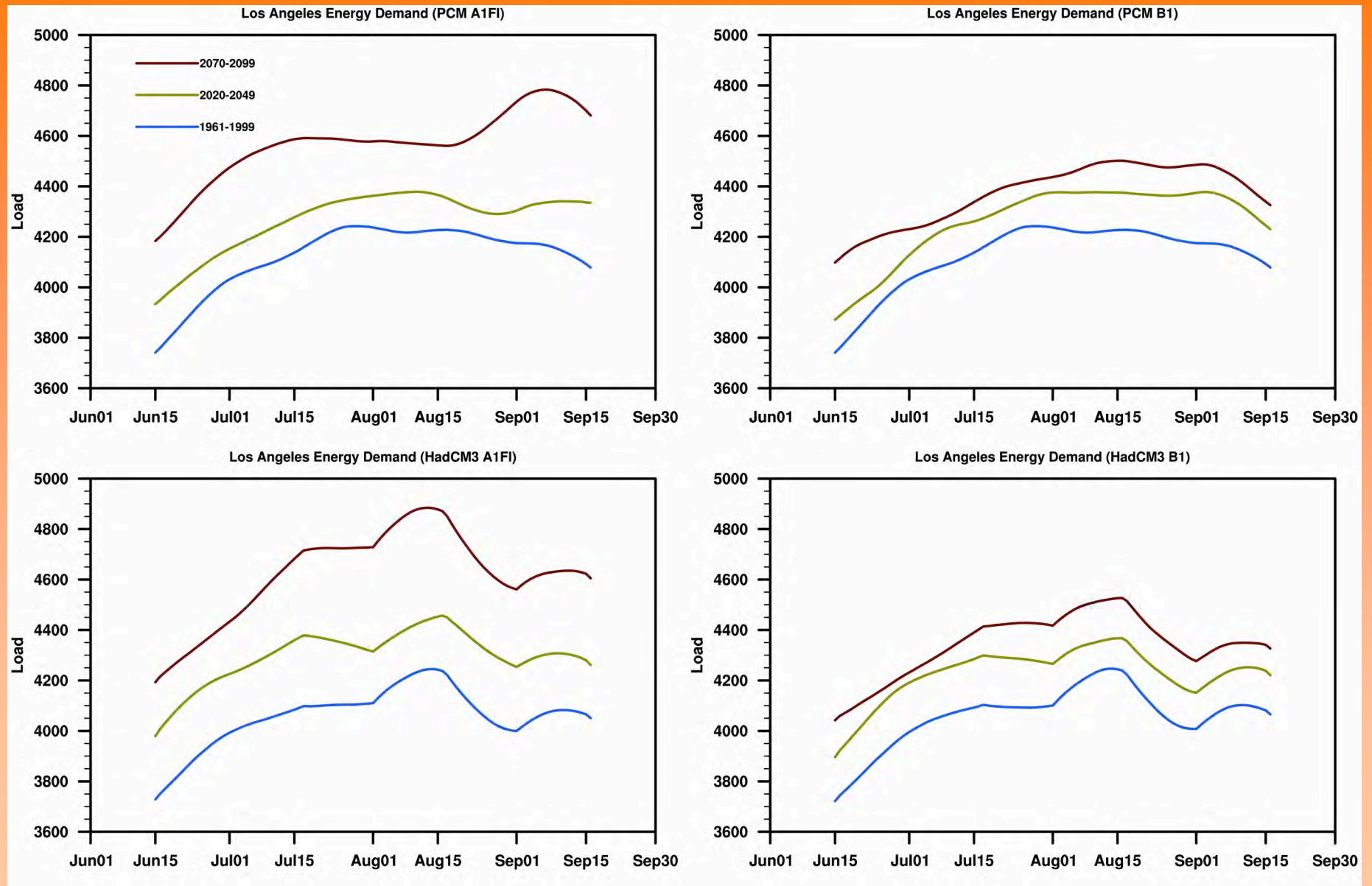
Heat Intensity Duration: Los Angeles



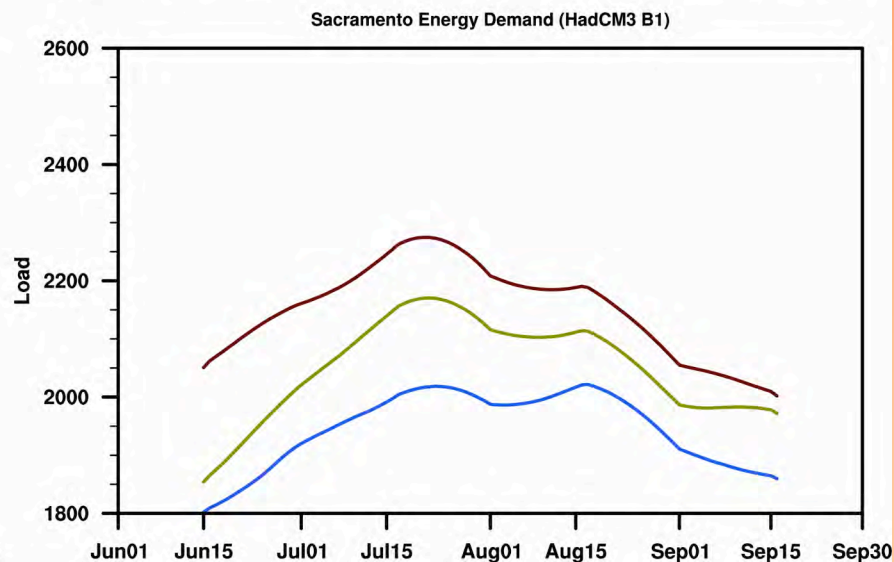
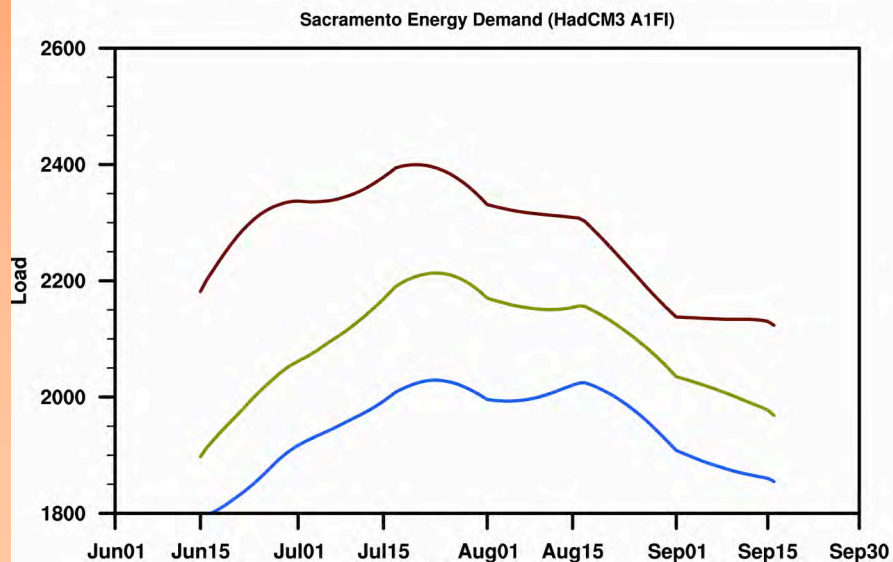
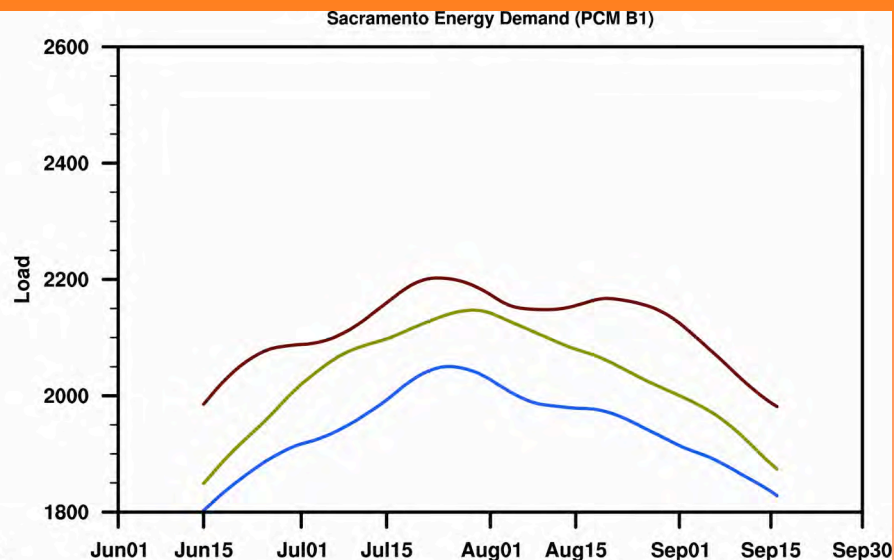
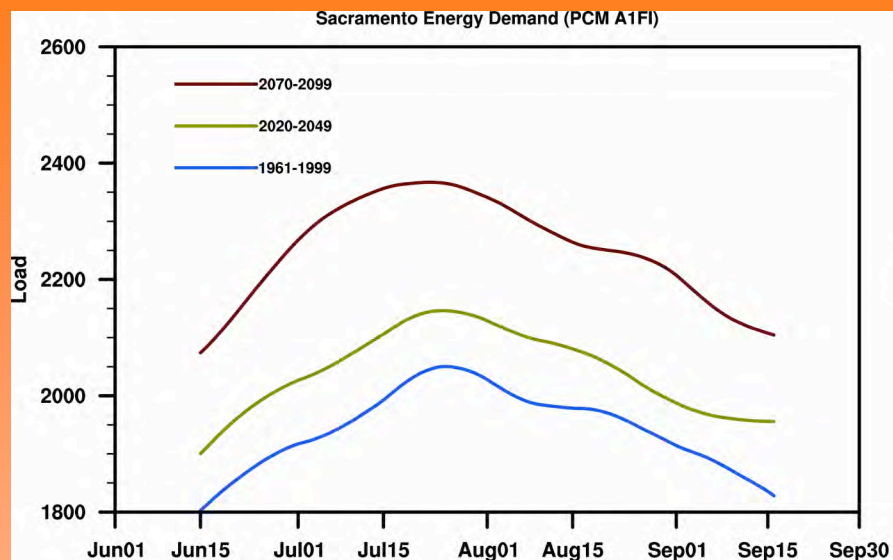
Heat Intensity Duration: Sacramento



Daily Climatological Energy Load: Los Angeles Summer



Daily Climatological Energy Load: Sacramento Summer



CONCLUSIONS

- **Analyses of AOGCM-projections indicates that heat extremes will likely be more frequent, more intense, and persist longer.**
- **Energy demand correlations indicate that California will likely exceed current capacity projections.**
- **Energy efficiency technologies can reduce energy demand.**
 - **Advances in materials research can decrease the impact on the power grid during heat extremes.**
 - **Albedo changes will decrease the urban heat island effect.**
- **Adaptation can reduce demand. Get people to replace air conditioning by fans and good circulation in residences.**